חמועצה המדעית לישראל

# BULLETIN
## OF THE
# RESEARCH COUNCIL
# OF ISRAEL

VOLUME II JUNE 1952 NUMBER 1

JERUSALEM

BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL



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### *Summary*

Every paper must be accompanied by a brief but comprehensive summary. Although the length of the summary is left to the discretion of the author, 5% of the total length of the paper is suggested.

(cont'd on inside back cover)

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## CONTENTS

# LA SÉISMICITÉ AU LEVANT*

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## 1. REMARQUES GENERALES

Notre catalogue bibliographique, compulsé de l'énorme littérature palestinologique comprend 500 fiches dont 200 de sources hébraïques, il n'est cependant pas encore complet. Il a pu, néanmoins, par les données hébraïques figurant la première fois dans l'étude macroséismologiques, permettre de faire la révision des renseignements connus précédemment (paiens, chretiens et musulmans). Nous pouvons ainsi avec moins d'hésitation étudier la nature de la séismicité levantine et même en dresser (là ou il est possible) des cartes et des diagrammes. Le travail est à son début (voir fig. 1).

Par manque d'espace, nous nous bornerons à nommer quelques uns seulement des auteurs, qui se sont adonnés à l'étude de la séismicité du Levant : – F. M. Abel; G. H. Arvanitakis; R. P. Berloty (Observatoire de Ksara); M. Blanckenhorn; C. Diener; B. Gutenberg et C. F. Richter; F. de Montessus de Ballore; C. Ritter; G. A. Smith; W. M. Thompson; B. Willis, et surtout A. Sieberg dont le livre sur la séismicité dans la Méditerranée orientale doit être considéré comme une oeuvre fondamentale, après les célébres catalogues de K. von Hoff et A. Perrey**.

## 2. LA SEIMISCITE AU LEVANT

Vers la fin du 19ème siècle la recherche géologique avait détérminé la position séismique du Levant dans le cadre mondial. a) Confinant Taurus-Chypre-Crète de la bande séismique transasiatique. b) Est compris dans les plissements autochtones qui forment le nord de la presqu'île d'Arabie. c) Fait partie des failles et Rifts Africans orientaux qui continuent jusqu'à Marache, en Turquie. L'examen macroséismique nous montre que la séismicité du Levant est d'ordre modéré. Les grands foyers se trouvent dans le sillon médian et dans la Méditerranée, non loin de la côte. Les montagnes sont des foyers de secousses localisées et plus faibles. Les tremblements de terre provoquent d'importants changements géomorphologiques : failles

* Ce travail est le résumé d'un rapport présenté en 1951 par l'auteur au Service National d'Irrigation et de Planification Hydroélectrique de l'Etat d'Israël. L'autuer a fait une communication sur le même sujet à l'Union Géodésique et Géophysique Internationale, Association de Séismologie, 9ème conférence qui eut lieu à Bruxelles, du 21 Août au 1er Septembre 1951. (N.D.L.R.)

** Cette étude préliminaire a été préparée en été 1950 au Bureau Central de Séismologie de Strasbourg. Je tiens à remercier ici M. le Professeur J. P. Rothé pour son aimable hospitalité et pour ses précieux conseils.

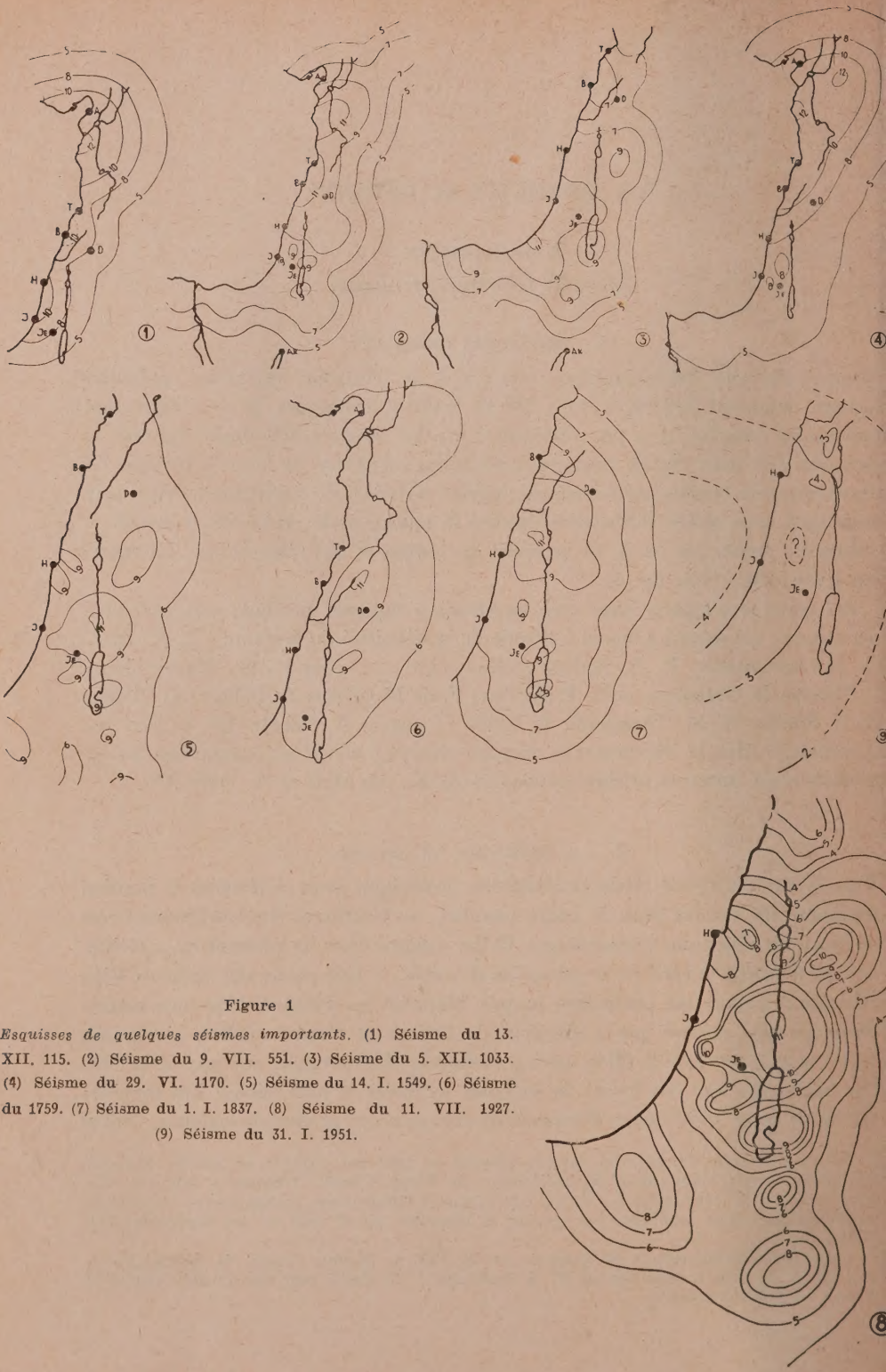


**Figure 1**

*Esquisses de quelques séismes importants.* (1) Séisme du 13. XII. 115. (2) Séisme du 9. VII. 551. (3) Séisme du 5. XII. 1033. (4) Séisme du 29. VI. 1170. (5) Séisme du 14. I. 1549. (6) Séisme du 1759. (7) Séisme du 1. I. 1837. (8) Séisme du 11. VII. 1927. (9) Séisme du 31. I. 1951.

récentes, perturbations notables dans les sources thermales volcaniques et Karstiques, déviations des cours d'eau, tsunamis fréquents prouvant la continuité des mouvements de la côte.

Quant à la séismicité du tronçon de la fente qui borde la Mer Rouge, par manque de données historiques suffisantes, nous devons nous prononcer avec plus de réserve que pour le Levant. Pourtant, mêmes les renseignements sporadiques que nous possedons nous enseignent que les tremblements de terre n'y sont pas rares, mais il semble que leur intensité soit moindre que celle du Levant.

### 3. LE PROBLEME DE L'INTENSITE

Les allusions littéraires nous permettent de noter 3 caractéristiques de la séismicité levantine : a )une période de plusieurs décades sans tremblements de terre notables, suivie de b) un tremblement de terre désastreux, enfin c) une période relativement courte d'activité séismique notable, mais non catastrophique.

Toute la littérature palestinologique est pleine d'allusions à de tremblements de terre faibles qui impriment leur caractère au Levant. Même les sèismes à intensité uniforme les plus étendus (comme celui du 31 janvier 1951) qui au dire d'un habitant "sont envoyés par le Tout Puissant pour nous imposer sa crainte" ne provoquent pas de dégtâs. Ils sont fréquemment mentionnés dans notre littérature.

Il est évident que dans l'étude macroséismique ce n'est que par les dégâts que nous pouvons juger de l'intensité d'un tremblement de terre. Mais nous avons pu

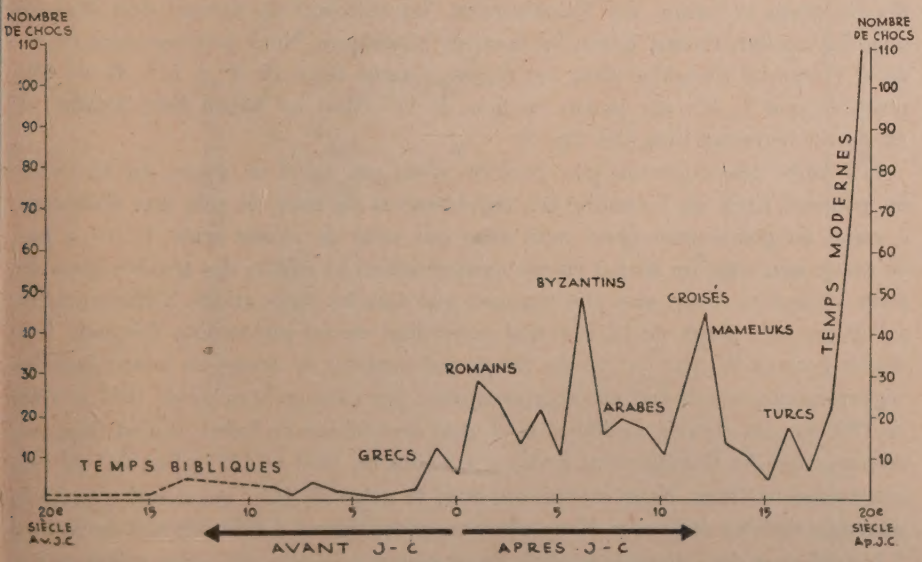



Figure 2

**Diagramme du nombre des chocs signalés aux differentes époques.**

nous convaincre aussi que le *silence des chroniques* ne signifie pas nécessairment l'absence de séismicité; dans la plupart des cas c'est la chronique qui a été perdue, ou le chroniqueur qui manquait. Le Levant a de tout temps été soumis à des régimes alternatifs; tantôt se toruvant dans l'orbite de la civilisation, tantôt rejeté en arrière. Les chroniques varient en conséquence, (et n'offrent pas de données uniformes pouvant être confrontées,) comme les chroniqueurs eux mêmes. La plupart offrent des lacunes aussi bien que de longueurs. Dresser des cartes séismologiques dans ces conditions, sans précautions suffisantes, peut fausser l'interprétation scientifique et pratique (voir fig. 2). En plus de ces difficultés y il a la difficulté d'ordre géographique. Le peuplement n'y est pas homogène. Les déserts y touchent des zones fortement peuplées. Celles-ci ne sont elles-mêmes souvent ni fixes ni stables; elles changent avec les époques historiques et les régimes. Les centres urbains étaient très importants, car ils servaient, de "séismographes". Mais leur sensibilité n'était pas égale a travers toutes les époques. C'est ce qui a donné lieu à l'idée, transmise par les chroniques, que les tremblements de terre cherchent à abattre les puissants du siècle en ébranlant les capitales. Cette impression vient du grand nombre des secousses notées (même les secousses faibles) dans la capitale, au temps de la prospérité, et du silence quand vient le déclin.

La grande séismicité d'Antioche, par exemple, n'est que fictive; elle provient des erreurs dans les chroniques byzantines et dans celles des croisés. Et de même pour Tibèriade, Safed, Nablus, Salt, Lydda, Ramleh, le Mont des Oliviers, Jéricho et d'autres, qui ont subi des dégâts importants même dans des sèismes relativement modérés. D'après nous, il n'y a pas eu de "siècles séismiques" comme l'ont admis des historiens et même des séismologues. La séismicité au Levant s'est déroulée sans fluctuations durant toutes les époques historiques. Nous pouvons donc considérer l'intensité séismique dans ces régions comme étant de 8° à 11°. Il est très probable que le 12° n'a jamais eu lieu; le 11° ètant lui même assez localisé et est particulièrement rare (voir fig. 3).

Les zones désertiques ou peu peuplées n'ont pas laissé de traces sur lesquelles on pourrait juger de l'intensité des tremblements de terre, et cela non seulement à cause du peuplement épars mais aussi par suite du climat aride. Il n'y a pas de doute que dans les aires à climat méditerranéen les dégâts des tremblements de terre, surtout en hiver, sont plus marqués que dans les zones arides. L'éffondrement a l'époque des pluies de bâtisses mal construites est un phénomène fréquent. Les dégâts occasionnés par les lourdes neiges qui tombent de temps en temps dans les régions montagneuses sont encore plus graves : par exampe la neige de 1833 et celle de 1837 qui ont ébranlé ou détruit la plupart des maisons de Safed; il n'est donc pas étonnant que les tremblements de terre survenus en 1834 et 1837 aient fait de très nombreuses victimes. Nous connaissons aussi la neige de 1857 qui a endommagé le quart des maisons de Damas. Nous même avons été témoin d'éffondrement de maison à Jérusalem et dans d'autres localités de montagne à la suite des fortes neiges de ces dernières années. La grande humidité de la saison pluvieuse fait gonfler la terra

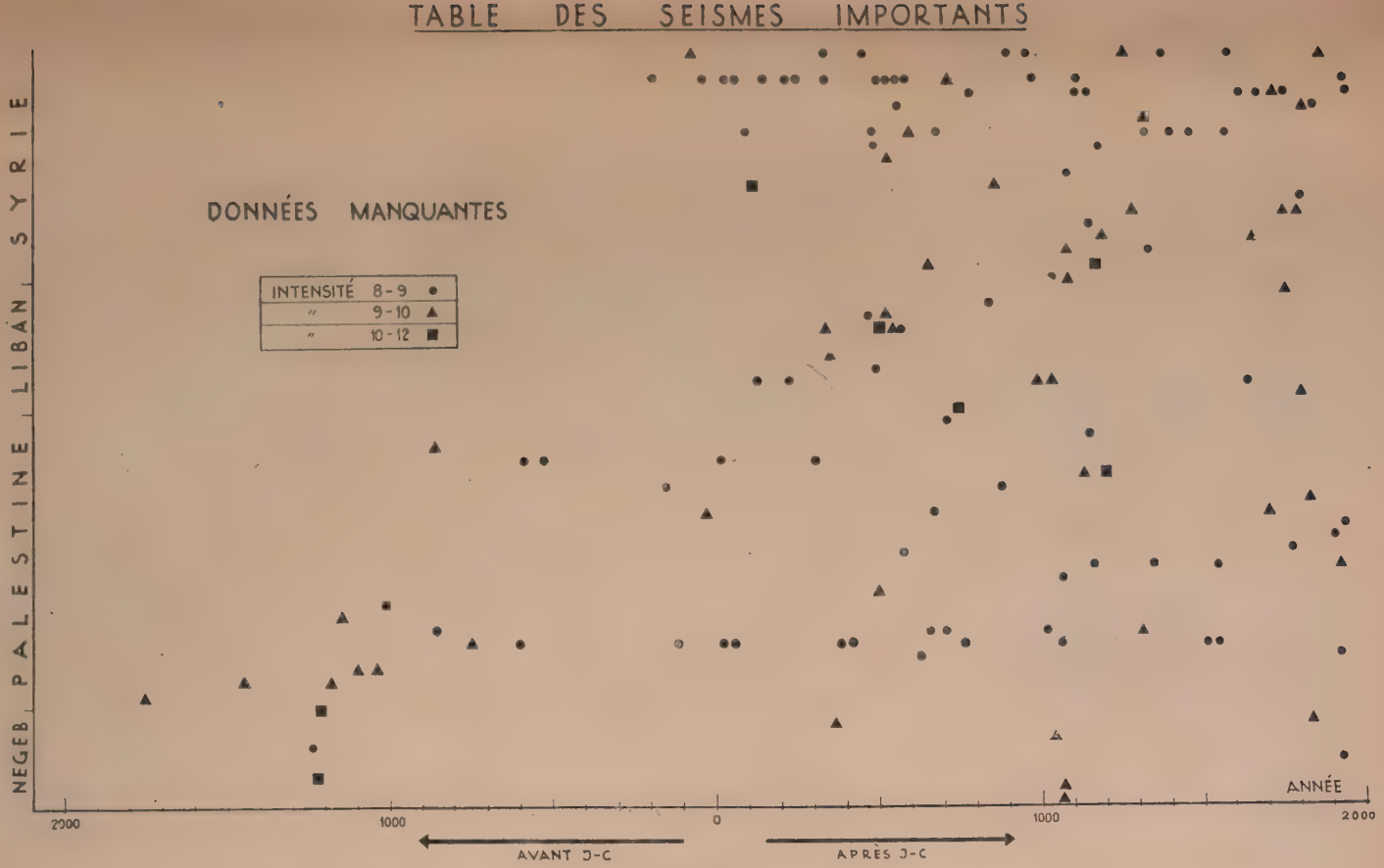


TABLE DES SEISMES IMPORTANTS
NEGEB PALESTINE LIBAN SYRIE
DONNÉES MANQUANTES
INTENSITÉ 8-9
" 9-10
" 10-12
ANNÉE
2000
1000
0
1000
2000
AVANT J-C
APRÈS J-C

Figure 3

rossa et la marne, et provoque des lézardes même dans les constructions massives; il est donc évident que si un séisme survient entretemps, les dégâts seront hors de proportion avec son intensité. Ce phénomène se manifeste surtout dans les nombreuses répliques qui suivent chaque séisme destructeur. C'est ce qui a donné naissance à l'ancienne croyance populaire Syrienne que les termblements de terre son plus fréquents à la saison des pluies qu'en été.

En hiver, non seulement les écroulements de maisons et les pertes de vies sont plus grandes, mais les habitants sont obligés de séjourner à ciel ouvert, exposés à la pluie et au froid, tandis qu'en été, les indigènes ont l'habitude de coucher dans les paillottes des vignes et des vergers, où les secousses sont moins ressenties. B. Willis a proposé de les baisser automatiquement d'un degré dans l'echelle d'intensités. Nous croyons que vu l'hétérogénéité des constructions il y a à examiner chaque cas en particulier.

### 4. LE PROBLEME DE LA FREQENCE

La valeur différente des données nous oblige de les classer en 3 groupes : a) les 50 dernières années. b) les 4 siécles derniers. c) a partir du XVIème siècle, en arrière, jusqu'aux temps les plus reculés. L'examen des secousses macroséismiques de ces 50 dernières années, qui comprennent un tremblement de terre considérable (11 juillet 1927), nous donne un tableau de la fréquence des tremblements de terre en général, et d'un tremblement de terre caractéristique dont le foyer se trouve dans la vallée du Jourdain. Notre liste comprend plus de 150 secousses, et elle a sans doute de nombreuses lacunes. Nous ne serons donc pas loin de la vérité en estimant le nombre des secousses annuelles à 6 environ; celles ayant atteint l'intensité VI n'étaient que 0.7; l'indice de séismicité* étant 18 environ (voir fig. 4).

A l'encontre des faibles secousses de cette époque récente, la liste des tremblements de terre des 4 derniers siècles ne signale que les tremblements de terre forts (environ 30 tremblements de terre du 9ème degré et au dessus), dont les foyers pouvaient être en Syrie, dans la vallée du Jourdain, en Idumée et même en Méditerranée, à proxomoté de la côte.

Il est naturel que les chroniqueurs de l'antiquité n'aient noté surtout que les forts tremblements de terre, mais la préoccupation des nombreux lieux saints leur a fait noter *de tout temps* les secousses qui les ont endommagé même faiblement. L'examen des données anciennes démontre la fréquence des tremblements de terre faibles et la rareté des tremblements de terre désastreux. Ces derniers n'ont presque pas échappé à l'observation des chroniqueurs, surtout depuis l'ère chrétienne, et particuliérement aux épques où les rapports avec l'Occident étaient reguliers. C'est le *hasard* qui caractérise les chroniques anciennes. Les grosses lacunes sont évdientes. Les rapports d'Israël avec la région Syrienne et Libanaise au temps biblique étaient moins étroits qu'avec les populations du sud. Les écrits

* nombre annuel de secousses par 100.000 km² de térritoire.

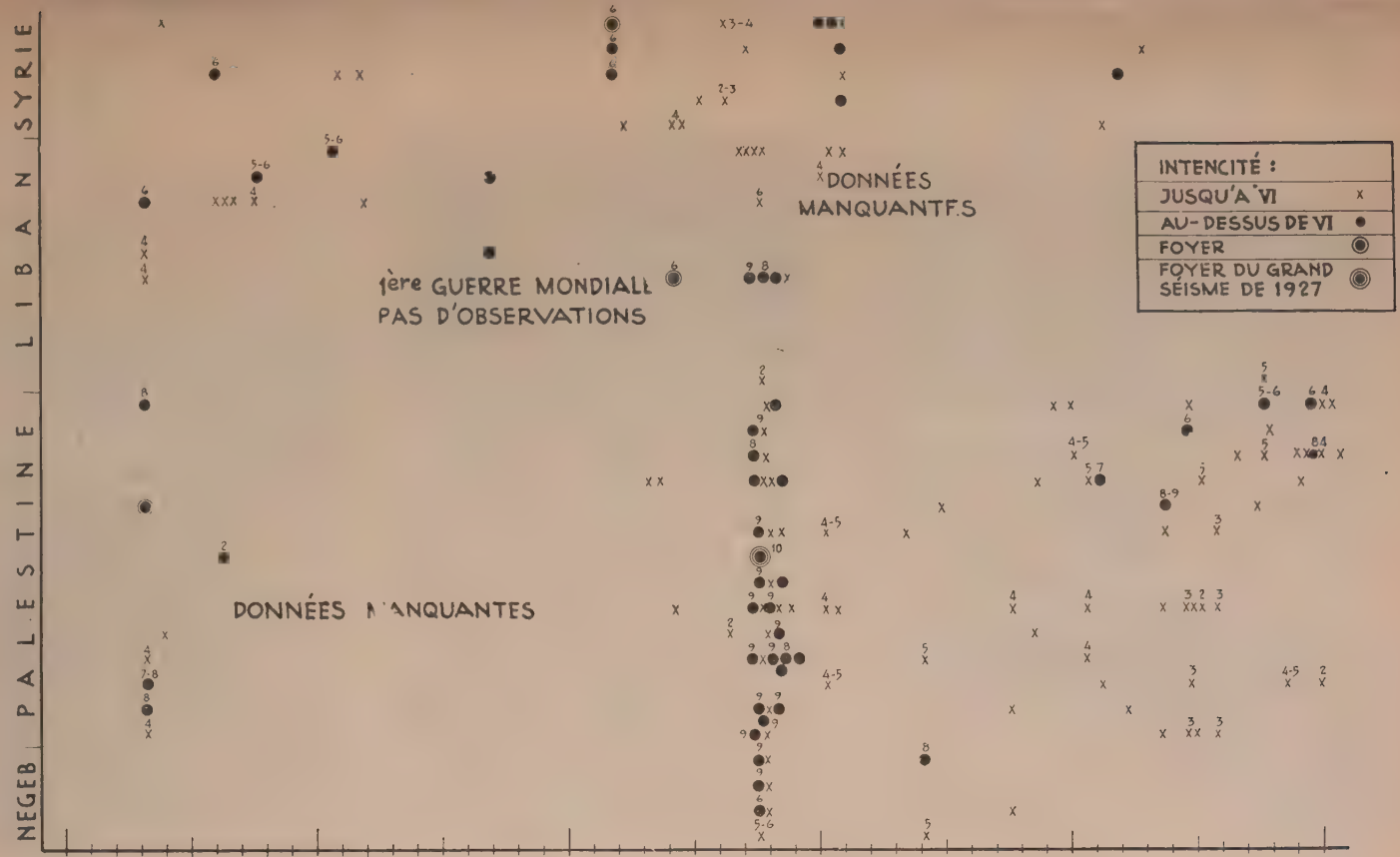

NEGEB PALESTINE LIBAN SYRIE
1ère GUERRE MONDIALE
PAS D'OBSERVATIONS
DONNÉES MANQUANTES
DONNÉES MANQUANTES
INTENCITÉ :
JUSQU'A VI
AU-DESSUS DE VI
FOYER
FOYER DU GRAND SÉISME DE 1927
1900
1910
1920
1930
1940
1950

Figure 4

d'Ougarith ne font pas mention de séismes, sinon par quelques rares allusions. Tandis que dans la Bible on parle de tremblements de terre dans certains chapitres dont les auteurs semblement avoir été des Syriens ou Libanais (p.e. le psaume 104); par eux nous pouvons avoir quelqu' écho de ces contrées. Lorsque dans la Bible une région quelconque, à une époque quelconque, est mentionnée, nous trouvons aussi mention des tremblements de terre qui l'affectent. C'est pourquoi il n'existe pas de livre dans la Bible sans mention de tremblements de terre, et parfois ce sont des descriptions complètes des séismes. La Bible nous montre que tout contact d'Israël avec une des nations environnantes a conservé des souvenirs de tremblements de terre: en Judée, en Samarie, en Philistie, en Phénicie, en Tranjordanie et dans les déserts du pourtour. Nous pouvons en conclure que les tremblements de terre y étaient tout aussi fréquents que de nos jours. Ce fait a été confirmé par les données relativement satisfaisantes des deux derniers siècles. Dans la littérature hébraïque postbiblique (Talmud) la grande fréquence des faibles tremblements de terre est nettement exprimée. Les renseignements y sont moins vagues que dans la Bible. Les auteurs du Moyen Age ont surtout noté les tremblements de terre violents et en donnent des descriptions exagérées. Les erreurs des chroniques sont nombreuses, mais en les confrontant avec les données hébraïques on peut y remedier en partie.

La littérature rabbinique palestinienne nous éclaire sur la fréquence des séismes dans le pays. Les auteurs du XIXe siècle ont noté très soigneusement la fréquence des séismes, identique à celle que nous avons observée pendant ces derniers 50 années. B. Willis déclare à propos de la séismicité palestinienne: "The *relieving shock* is a great Earthquake which exhausts the accumulated energy and is followed by a long period of quiet lasting 20 to 100 years." Dans les dernières 2000 années il y a eu 40 tremblements de terre violents à intervalles moyens de 50 ans. Mais l'examen des 127 tremblements de terre (du 8e degré et au-dessus) survenus pendant cette même époque, montre qu'une moitié de ce nombre s'est succédé à des intervalles de 0—10 ans. Le quart-à des intervalles de 10—20 ans. Et leur nombre diminue à mesure que les intervalles augmentent. Les grands intervalles de 50, 60 et 70 ans qui ne donnent que de rares tremblements de terre, sont, à notre avis, fictifs, en tant qu'appartenant à une époque de regression sociale où l'on ne se préoccupait pas de noter les séismes. (voir fig. 5).

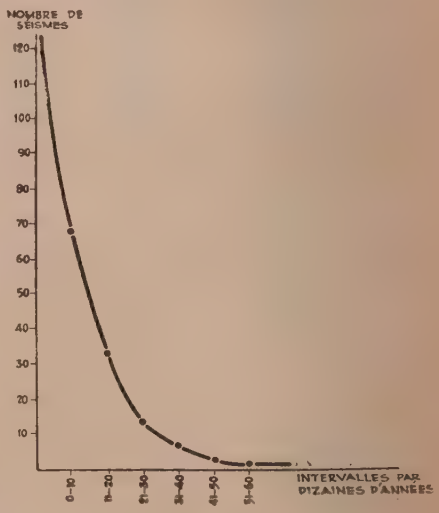
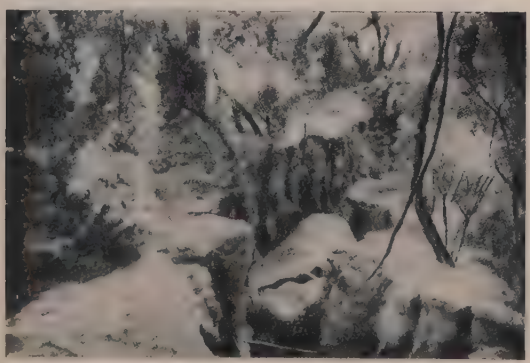



**Figure 5**

Diagramme du nombre des séismes par intervalles de dix ans.

*Lydda* — Séisme du 11.VII.1927.

*Nablus* — Séisme du 11.VII.1927.



*Au bord du Jourdain* — Crevasses déterminées par le Séisme de 1927.

La colonne penchée depuis le tremblement de terre de 1759.

### 5. SEISMICITE REGIONALE*

Les quatre bandes longitudinales de la division physique du Levant : le littoral, la montagne occidentale, le sillon médian et le plateau oriental se différencient aussi dans leur activité séismique. Ce relief est le résultat de la tectonique levantine. Les Rifts et les failles à tous leurs degrés jouent le rôle décisif dans l'activité séismique, comme cela se voit aussi en Californie, dont il faut la rapprocher. Le Levant est formé essentiellement de calcaire, et les tremblements de terre y rajeunissent fréquemment le Karst; c'est en effet dans les régions les plus morcelées : en Samarie, en Galilée, au Liban et en Syrie du Nord, que le Karst s'est surtout développé. Le séisme provoque, entre autres, l'abaissement du niveau de base Karstique, il fait disparaître des sources et, par suite, les localités voisines sont abandonnées de leurs habitants (comme une partie des Villes du Désert (Josué XV), qui étaient le long de la Mer Morte) les moulins à eau dans le ouadis des montagnes sont alors délaissés.

Nos données qui s'étendent sur 4000 ans environ, prouvent cependant, malgré leur valeur inégale, que la séismicité régionale n'a pas changé essentiellement depuis les premiers temps bibliques.

#### a. *La Bande Littorale*

Cette bande est fréquemment mentionée comme l'une des plus affectées par les séismes au Levant. Il est évident que les villes florissantes, le contact avec l'Occident, et le peuplement plus dense qu'à l'interieur, sont cause de cette abondance des données. L'examen microséismique des derniers tremblements de terre a montré que nombre de séismes ont leurs foyers dans la Méditerranée, à proximité de la côte. La tectonique côtière témoigne elle aussi d'une séismicité active et l'on a l'impression que l'intensité des sèismes dont les foyers sont dans le fond de la mer à proximité de la côte est plus grande que celle des séismes à foyers terrestres. Il se peut que cette impression soit dûe aux raz de marée relativement fréquents (on en connait plus d'une vingtaine; en dehors de quelques uns douteux) qui ont causé de grands dégâts. La bande n'est pas entièrement uniforme. Le lien entre le degré de séismicité et le morcellement est visible. On peut ainsi la diviser en 3 tronçons : le syrien, le libanais, et le sud palestinien (voir fig. 6).

#### b. *La Montagne*

L'examen des données dans ces dernières 50 années, même celles des 4 derniers siècles, qui sont assez sûres, montre que la bande montagneuse occidentale est affectée de séismes à intensité modérée ou faible. L'anticlinorium judéen entier y apparaît particulièrement faible en comparaison des blocs de Samarie, de Galilée, du Liban et des autres blocs septentrionaux morcelés qui tremblent souvent.

* Nous avons mentionné p. 5 trois causes possibles de la séismicité au Levant. En étudiant la tectonique des "lignes érythréennes" (fissures, failles, rifts, etc. dirigés, comme la Mer Rouge, NW—SE), nous voyons que les coulées de lave sont partout liées à ces fissures, et il nous paraît très probable que les différences régionales de l'intensité séismique est la conséquence de ces "lignes" de perturbation. (Pour les détails, voir les comptes-rendus du *Congrès Géologique International 19ème Session — Alger 1952* sur "La Mer Rouge et les lignes érythréennes".


Figure 6
Epicentres et aires pléistoséistes des séismes importants.

### c. *La Vallée du Jourdain*

A une séismicité considerable, mais elle n'apparaît pas comme une unité, il faut y distinguer plusieurs régions actives : i. région d'Akaba (?). ii. Région de Petra dans l'Araba (?) (ces deux régions manquent de données suffisantes). iii. Le Sud de la Mer Morte. iv. La vallée du Jourdain en face de la Samarie. v. La vallée de Tiberiade. Dans les tremblements de terre les plus violents, il arrive que les zones pléistoséistes à forte intensité s'étendent aussi à la montagne des deux côtés de la vallée. Les chroniques mentionnent même des tsunamis dans la Mer Morte et dans le Lac Tibériade.

### d. *Le Plateau Oriental*

Malgré les données sporadiques que nous possédons, surtout sur sa partie méridionale, il est probable que les séismes à différentes intensités y sont fréquents. Ceci est dit à moins que l'étude microséismique ne démontre a l'avenir que les foyers se trouvent das les tronçons des Rifts, ou dans les failles voisines de l'ouest. Cette zone peut se diviser en plusieurs régions : La montagne d'Idumée au sud, le Hauran, la région de Damas et la région d'Alep.

### e. *Le Negev*

En dehors de la partie côtière qui est notablement séismique, nous manquons de données sur l'intérieur du Negev. Il est vrai que cette zone est désertique et non peuplée, mais à l'époque byzantine ce pays avait une forte population et les liens avec le monde byzantin, et surtout avec Antioche étaient très étroits. Néanmoins nous ne sachons pas qu'il y fût noté de séismes.

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ADDENDUM

### *Le Tremblement de Terre du 31 Janvier 1951*

La nuit du 31 janvier à 01,07 heures (heure d'Israël) un séisme secoua la Palestine entière et les régions limitrophes d'Egypte et du Liban. Les données de l'obser-

vatoire de Strasbourg qui m'ont été spécialement communiquées sont les suivantes : pour la secousse éprouvée dans les parages ci-dessus, le 30/1.

| | | |
|---|---|---|
| i P | 23h | 12m 53s |
| e p P | 23h | 13m 21s |
| e S | 23h | 17m 14s |
| i S | | 17m 17s |
| e s S | | 17m 56s |

Les coordonnées approximatives étant 33°8 E. 32°1 N.; l'épicentre se trouvait en mer, à 100 km de la côte, au large de Jaffa, et le foyer (h) à 130 km de profondeur. J'ai recueilli des renseignements d'env. 100 localités d'Israël (à partir d'Elath à l'extrême sud, jusqu'à la frontière Syrienne au nord), qui m'ont permis de dresser la carte ci-jointe (voir fig. I, No. 9). Malheureusement n'ayant pas de données détaillées des régions voisines j'ai dû en tracer les isoséistes en lignes interrompues. Il est à supposer que la région de Port-Said, très proche de l'épicentre a dû ressentir la secousse plus que tout autre endroit sur terre ferme et que l'intensité y a été du 4$^{me}$ degré à peu près. Par contre, l'intensité au Caire et ses environs, aurait été entre le 2$^{me}$ et le 3$^{me}$ degré. (Des données plus précises peuvent être obtenues à l'Observatoire séismologique de Helóuan).

En Israël même, autant que j'ai pu l'établir, l'intensité n'a, nulle part, atteint le 4$^{me}$ degré; exception faite pour une région limitée en Basse Galilée. Dans ce cas on ne peut pas se laisser impressioner par les descriptions des journaux.

L'isoséiste 4 se trouve tout entier en mer. Jusqu'à la latitude de Jaffa il court parallèlement à la côte. A partir de là, vers le Nord, il tourne à l'ouest.

Il est à noter que le Saron a la tendance d'affaiblir l'intensité des séismes (comme nous l'avons démontré surtout pour le tremblement de terre du 11 juillet 1927, dont nous avons de nombreuses données) (voir fig. 1, No. 8). La cause en est probablement à la "flexure" benjaminienne qui s'étand de la Mer Morte au Nord de Jaffa, divisant la Palestine centrale en deux unités tectoniques distinctes : Samarie et Judée; il se peut que la localisation du foyer dans notre séisme ait eu son influence sur la séismicité de ce point sensible.

L'isoséiste 3 passe le long du versant oriental du pays, à partir de l'Est de Beer Cheba, Hebron, Bethlehem, Jérusalem et Nablus, jusqu'à Beisan. De là il continue parallèlement au Jourdain et à la côte occidentale du Lac de Tiberiade – dans la direction de Ras-en-Nakoura (au Sud de Tyre). Un nucléus de 3$^{me}$ degré se trouve à l'est de la Haute Galilée, sur la pente qui regarde la vallée de la Hulé.

L'isoséiste 2 est hypothétique, il faudra peut-être le reculer à droite ou a gauche une fois les données exacteés obtenues d'Amman (capitale de Trans-Jordanie), de Damas, de Beyrouth, du sud de Chypre et du Caire. A Elath, l'Akaba israëlienne, ainsi que dans l'Araba du sud (Beer-Ora et Ebrona) le séisme n'a pas été ressenti.

# SUPPLEMENTATION OF NITROGEN IN ORANGE PEELS FOR CATTLE FEEDING

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The feasibility of substituting urea or ammonium salts for part of the protein in feed for ruminants has been indicated in literature[2,5,5]. The applicability of such procedure is, however, considerably circumscribed by the tendency of urea to reduce milk yields[1] and the detrimental effects of ammonium salts on the acceptability of the feed due to the fumes of ammonia[4,8]. Moreover, some 25 per cent of the additional nitrogen remains unabsorbed after passage through the alimentary system[7]. It has also been established that a considerable quantity of digestible carbohydrates is requisite for the effective utilization of nitrogen[6].

It seems that all these shortcomings have been due to the fact that in all previous supplementation experiments, nitrogen was merely incorporated mechanically. Following the advice of Prof. Lepkovsky, the authors embarked on experiments stipulating a chemical link between the feed and the supplementary nitrogen. Orange peels seemed to offer favourable prospects, in view of their acid reaction and high content of digestible carbohydrates. It was presumed that ensilage would further increase the absorbability of nitrogen by raising the acidity of the peels. Ammonium hydroxide suggested itself as a suitable nitrifying agent on account of its low cost.

It was assumed that chemical absorption of nitrogen by the organic matter would enhance palatability and make for higher nutritive value, compared with mechanical incorporation of nitrogenous salts. Substitution of nitrogen-enriched orange peels for a portion of proteins normally provided in the ration, seemed to offer a prospect of saving on cake consumption, apart from increasing the feeding value of a widely available material. The admixture of an ammonium compound should present no great technical difficulties, as the operation could be fitted into the industrial routine of processing peels for cattle feed.

## MATERIALS AND METHODS

Ammonium hydroxide was added to the following categories of peels : (1) fresh peels, (2) low-carbohydrate peels, which had passed the process of extraction for alcohol production (hereafter referred to as "processed"), (3) peels ensilaged for a period of two months (silage), and (4) both processed and ensilaged for two months (processed silage).

The dry matter content and pH were determined for all four categories. The pH

was measured in juice extracted by a hydraulic press; in the case of ensilaged peels, from which the juice is readily liberated, hand-pressing was sufficient. The result of the determinations are given below :

| *Category of peels* | *Dry matter content (per cent)* | *pH* |
|---|---|---|
| 1. Fresh | 20.7 | 3.5 |
| 2. Processed | 22.4 | 4.9 |
| 3. Silage | 14.0 | 3.5 |
| 4. Processed silage | 19.7 | 3.7 |

The high pH value of the processed peels, as compared with the other samples, should be noted.

Free acid in peels was assayed by titration with N/10 caustic soda. The amount of N/10 NaOH required to neutralize the acid in a fresh sample was 3.16 and 4.14 ml per gram for non-processed and processed peels, respectively.

Nitrogen supplementation was accomplished by agitating the peels for several minutes in a glass jar containing a solution of ammonium hydroxide and then leaving them in the closed jar for an hour. One sample of each category was treated with 2% ammonium hydroxide, another with 4% solution in sufficient amount to ensure complete saturation. After the treatment the samples were dried for dry matter determination.

Dry matter, nitrogen and pH were determined in the treated as well as in untreated control samples. For pH determiation in the treated samples, the dried material was ground and made up with distilled water into a thick pulp.

## RESULTS AND DISCUSSION

A comparison of nitrogen content in treated and untreated peels is given in Table I, while Table II shows the pH values.

TABLE I

*Nitrogen content in dry matter (per cent)*

| *Category of peels* | *Before treatment* | *After treatment with ammonium hydroxide* | |
|---|---|---|---|
| | | 2% solution | 4% solution |
| 1. Fresh | 1.0 | 1.9 | 2.1 |
| 2. Processed | 1.0 | 1.4 | 1.7 |
| 3. Silage | 1.2 | 2.6 | 2.8 |
| 4. Processed silage | 1.1 | 2.5 | 2.7 |

It is evident that as a result of the treatment, the nitrogen content doubled in fresh peels, whereas in processed peels the percentage increased about 1.5 times. There is no apparent difference in the effect of the treatmet between the two remaining categories (3 and 4), the nitrogen content having increased in both types of

silage 2.3—2.5 times, i.e. considerably more than in the non-ensilaged samples. For all categories there appears to be a somewhat more pronounced effect with the higher concentration of ammonium hydroxide.

TABLE II

*The pH values in the dried material*

| *Category of peels* | *Before treatment* | *After treatment with ammonium hydroxide* | |
|---|---|---|---|
| | | 2% solution | 4% solution |
| 1. Fresh | 4.3 | 4.9 | 5.3 |
| 2. Processed | 4.4 | 5.3 | 5.8 |
| 3. Silage | 3.8 | 4.4 | 4.6 |
| 4. Processed silage | 4.1 | 5.1 | 5.3 |

The treatment resulted in a marked increase of the pH values.

Considering the amount of free acid, 100 gms of ensilaged peels could theoretically absorb 0.44 gms nitrogen. In the dry matter the percentage of nitrogen should increase by 3.2, thus bringing the total percentage of nitrogen, together with that present in the peels before treatment, to 4.4%. However, the actual increase only amounted to 1.6%, i.e. half of the calculated absorptive capacity. 100gms of processed and ensilaged peels could, on the basis of their acid content, tie up 0.58 gm nitrogen. In the dry matter the percentage of nitrogen should theoretically increase by 2.9, bringing the total content (inclusive of the nitrogen already present before treatment) to 4.0 percent. Although both ammonium hydroxide solutions provided a surplus of nitrogen, the post-treatment percentage of nitrogen only rose by 1.6, i.e. only by little more than half of the theoretically possible increase. The imperfect absorption can be accounted for by one or both of the following causes: (a) the nitrogen does not react with some of the acids, (b) the ammonium salts formed by some of the acids are unstable under conditions of high temperature drying. It has been established that orange-peel silage contains some 1 per cent lactic acid and about 3.7 per cent acetic acid in the dry matter. However, their relative nitrogen-absorbing capacity is unkown.

The product obtained after drying seems to be characterized by considerable stability of the nitrogen bonds, since a high percentage of nitrogen is retained in spite of prolonged drying at high temperature. It remains to be ascertained wether any nitrogen is lost under normal storage conditions. The firmness of the bond is also indicated by the absence of any detectable ammonia in the dried product, in contradiction to earlier information. It has been reported[4] that feeds enriched with urea or amonium salts frequently give off a smell of ammonia.

The ammonium hydroxide treatment produced some darkening in peel silage. The colour of non-ensilaged peels was not affected at all by a 2% solution of ammonium hydroxide, while treatment with a 4% solution resulted in light darken-

ing. Apart from such discolouration, the product does not differ in its appearance from dried peels normally marketed in Israel.

In the light of these results the use of nitrogen-enriched peel silage as fresh feed seems feasible.

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SUMMARY

1. The experiment was designed to raise the nitrogen content of fresh, processed (for alcohol extraction) and ensilaged orange peels by treatment with ammonuim hydroxide.
2. 2 and 4 per cent solutions of ammonium hydroxide increased the nitrogen content 2 and 1.5 times in fresh and processed peels, respectively.
3. In such peels after subjection to ensilage for two months, the same treatment increased the percentage of nitrogen 2.3 to 2.5 times, on account of the high acid content.
4. The product obtained after treatment with ammonium hydroxide differed little in its appearance from dried peels normally marketed in Israel.
5. The stability of the nitrogen bonds was indicated by the absence of ammonia smell, as opposed to mixtures prepared elsewhere which, probably because of the smell, were not readily accepted by cattle.
6. The interrelation between the pH values and the amounts of fixed nitrogen suggests that the nitrogen combines with the acids present in the peels.
7. Nitrogen apparently forms stable organic salts with only some of the acids occurring in orange-peel silage, since the total absorptive capacity of the acids considerably exceeds the amount of nitrogen actually fixed.

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# ISOLATION OF COLCHICINE FROM *COLCHICUM** *HIEROSOLYMITANUM* FEINBR.

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*Colchicum Hierosolymitanum* Feinbr. occurs abundantly in the hills of Jerusalem and also in some parts of the Negev. In the course of an investigation sponsored by the Research Council of Israel, the colchicine content of this species and the possibility of the isolation of the alkaloid in practical quantities was studied.

For the corm of the closely related *Colchicum autumnale,* colchicine values ranging from 0.032% to 0.2% have been reported[1,2], whilst Anderson, Fischer and Arrigoni[3] found in an unspecified variety 0.33% and Beer and co-workers[4] in the bulbs of *Colchicum Speciosum* from 0.4% to 1.6%, depending on the season in which the alkaloid content was determined.

Hans Moser[5] has reported the interesting observation that some alkaloid is lost, when the harvested product is not "stabilized" immediately. It is further of practical importance that *Colchicum* is characterized by an extremely high starch content.

The local variety was harvested once in November, once in June, in both cases in the neighbourhood of Jerusalem. The airdried corm (weight loss 78% and 83%, respectively) showed a colchine content of 0.101% and 0.093%, respectively (0.022% and 0.016%, calculated on fresh weight). In the latter case, also non-dried material was analysed, and a value of 0.018% of the fresh weight was found. It appears, therefore, that the prolonged drying is not accompanied by any decomposition of the alkaloid; also the seasonal variation in this local variety is not significant.

## ANALYTICAL METHODS

The two known methods for the determination of the alkaloid, based on extraction with alcohol and water, respectively, were studied in detail, in the hope of adapting them to the practical isolation of the alkaloid. The water method[6,7], gave well reproducible results, but proved rather cumbersome because of the formation of emulsions by the starch present in the corm. Anderson and co-workers[3] have, therefore, advocated a prior hydrolysis of the starch with taka-diastase; indeed, this additional step represents a great improvement in the method.

From the point of view of the analyst, the alcohol extraction method of the British Pharmacopoeia[6] is the method of choice; the alkaloid is ultimately weighed. This method has been modified by the Swiss Pharmacopoeia[7] and by Fischer and

* Received November 1951.

Frank[8] through the application of adsorption technique. Also iodometric[9], colorimetric[10] and polarographic[11] methods have been used to improve upon the basic procedures, but no particular advantage has been found in these modifications.

## ISOLATION OF COLCHICINE

### *a. Extraction with alcohol*[6,12]

Although, as stated above, alcohol can extract the alkaloid quantitatively from the plant material, it cannot be considered as a practical solvent, when the treatment of large quantities of material is necessary. Repeated extractions, involving a quantity of solvent, 10—20 times the weight of the plant material, are required, part of the alcohol (about 0.8 parts per part of material) is lost through firm absorption in the material, and a large amount of resinous by-products is extracted with the colchicine. The accompanying impurities, it is true, can be removed by treatment of the crude residue of the extract with sodium sulfate solution[8] and extraction with ether, but this additional step is cumbersome. The crude alkaloid obtained is 50% pure.

### *b. Extraction with water*

Extraction with water usually gives emulsions which can be broken only with difficulty. This obstacle can be overcome by enzymatic hydrolysis of the starch (until the iodine test is completely negative); indeed, complete extraction is possible under these conditions. However, the isolation of the alkaloid from the aqueous extract by standard methods involves precipitation of by-products by means of lead acetate ($^1/_4 - ^1/_3$ of the material is required), removal of the lead excess with a hot solution of disodium phosphate and the eventual concentration of a very large volume. The crude alkaloid so obtained is 30 – 40% pure.

### *c. Trichloroethylene*

In a systematic search for other solvents, it was found that trichloroethylene is an effective and almost selective solvent. Ten volumes of the boiling chloro-compound extract the alkaloid within one hour and the crude product is 70% pure. As shown in the experimental part, the alkaloid can be purified completely even without the use of chromatographic methods. From a practical point of view, trichloroethylene has the additional advantage that it is not retained by the plant material and that, therefore, the operational losses are insignificant; it should also be borne in mind that the heat requirements for its vaporization are small as compared with those of alcohol or water.

### *d. Chromatographic Purification of Crude Colchicine*

Already Ashley and Harris[13] have described the purification of colchicine by adsorption from a chloroform solution on activated alumina. However, this method is applicable only when the alkaloid is already fairly pure. The crude products

obtained by alcohol or water extraction did not respond favourably to the treatment. Although part of the colour was easily removed, the melting point of the eluted product was not satisfactory. On the whole, no formation of distinct zones of adsorbed material could be achieved, and the separation of fractions had to be arbitrary.

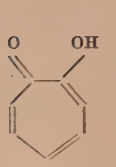
In accordance with the general experience of Catch, Cook and Heilbron[14], and the observations made by Evans and Partridge[15] on the separation of hyoscyamine and hyoscine, it was found that chromatography on silica gel represents an efficient method of purification for colchicine. As stated by Munier and Macheboeuf[16] clear zones of the alkaloid were obtained when the pH was kept low (in neutral medium, gradual dissociation takes place and the adsorption becomes obtuse). This condition was achieved by treating the chloroform-ether solution before adsorption with a 2.5% sodium hydrogen sulfate solution (pH = 1.2). The colchicine ring was eluted with alcohol, and a very pure substance was obtained in excellent yield. Similar results could be obtained with a chloroform solution of the alkaloid on silica gel, impregnated with N/5 sodium phosphate-citric acid buffer solution (pH = 2.65).

It is to be expected theoretically that very high pH will have the same enhancing effect as low pH. Indeed, on silica gel, impregnated with sodium carbonate solution (pH = 10.2), a benzene solution of the crude colchicine gave a very distinct zone of the pure alkaloid. From a practical point of view, it may be indicated to subject the crude alkaloid to successive adsorption on a high and a low pH column. Different solvents have to be used at different pH, because of the change in solubility of the alkaloid under these conditions (partial salt formation at low pH).

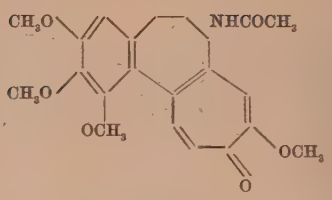
### *e. Refining Experiments with Ion Exchange Resins*

Quinine[16] and atropine[17] have been purified successfully by the method of ion exchange. The difficulty has been experienced in these cases that strongly acidic cation exchangers can be eluted only with difficulty; more normal behaviour was shown on weakly acidic resins (carboxylic, not sulfuric acid type), but these resins will absorb only bases with a $pH < 10$ [18]. For this reason, the ion exchange method did not seem particularly suitable for colchicine which has $K = 4.5 \times 10^{-13}$ [19], (quinine: $K_1 = 1.0 \times 10^{-6}$; $K_2 = 1.3 \times 10^{-10}$; atropine $K = 4.5 \times 10^{-5}$), on the other hand, the molecular size of the alkaloid is not so large that the capacity of the resin would be unduly reduced[20].

The experiments carried out with pure colchicine solutions showed that on the strongly acidic Amberlite IR – 100 H, both adsorption, and elution with alcohol or ammonia was slow; no elution was possible with N/1 hydrochloric acid. On Amberlite IRC – 50, the alkaloid was – notwithstanding the literature data – adsorbed fairly well, and elution was possible with alcohol, ammonia or hydrochloric acid. Surprisingly, adsorption was effected also with the strongly *basic* Amberlite IRA – 400. Possibly the tropolone-like structure of colchicine[21] is responsible for




Tropolone




Colchicine

this feature – alcohol or 10% sodium chloride solution eluted the alkaloid well from the resin column. Unfortunately, these encouraging results were vitiated by the specific properties of the other constituents of crude colchicine solutions; both the accompanying ions and the viscosity (polysaccharides) made the adsorption extremely slow and reduced its practical value to nil.

## CONCLUSION

Extraction of the plant material with trichloroethylene or with water, followed by chromatography, gives a pure alkaloid preparation. Colchicine so obtained and recrystallized from ethyl acetate is a yellowish, crystalline compound of m.p. 155° – 156°. It is submitted that its production from local plants is of practical interest. Colchicine is being used in an increasing measure in plant breeding[22,23] and for medical purposes[24,25]; its antimitotic properties[26] make it an interesting starting material for research in many fields of scientific endeavour.

## EXPERIMENTAL

### 1. *Alcohol Extraction*

The results are summarized in Table I. The extracts were further treated according to reference 6.

TABLE I

| Exp. No. | Weight of plant (g) | Size (mesh) | Crude alkaloid (g) | (% of total alkaloid in sample) | Remarks |
|---|---|---|---|---|---|
| 1 | 200 | 20 | 0.073* | 36.3 | Soxhlet. |
| 2 | 1100 | 20 | 0.353 | 31 | Soxhlet with heated jacket. |
| 3 | 800 | 40 | 0.30 | 35 | Extraction with 3.5 l. of alcohol for one hour; addition of 2 l. of alcohol and further extraction. |
| 4 | 600** | 40 | 0.3896 | 65 | Heating period: 2 hours. |

* Chromatography on alumina gave 0.037 g of pure colchicine.
** 3.7 l. of alcohol were used.

### 2. *Water Infusion*

The experiments are described in Table II. In experiments 1 and 2, the method of the "Handbuch der Pflanzenanalyse"[27], in experiments 3 and 4 that of Anderson, Fisher and Arrigoni[3], was used.

In all cases, the residue was taken up in ether, a concentrated sodium sulfate solution added, and the ethereal layer treated with water. The aqueous solution was then extracted with chloroform. The solvent was distilled off and alcohol added so as to decompose the chloroform compound. The alkaloid was further purified by chromatography on alumina, and obtained in form of a yellow powder, m.p. 90° – 140°.

TABLE II

| Exp. No. | Weight of plant (g) | Size (mesh) | Amount of solvent used (L.) | Crude alkaloid (g) | (% of total alkaloid in sample) | Chromatography on alumina (g) | (%) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1 | 700 | 7–20 | 5 | 0.664 | 94.5 | | | Temp. 60—70°; the liquid was repeatedly decanted and replaced by fresh water. Precip. with lead acetate centrifugation. |
| 2 | 600 | 8–20 | 2 | 0.405 | 76.0 | 0.112 | 18.6 | 1 hour 60—70°; separation by hydraulic press. Precip. with $NaHPO_4$, in presence of acetic acid. |
| 3 | 150 | 40 | 1.5 | 0.306 | | 0.097 | 67.6 | Starch decomposed with taka-diastase. |
| 4 | 450 | 40 | 4.5 | 0.597 | | 0.260 | 53.3 | ditto. |

### 3. *Trichlorethylene Extraction*

TABLE III

| Exp. No. | Weight of plant (g) | Size (mesh) | Amount of solvent used (L.) | Crude alkaloid (g) | (% of total alkaloid in sample) | Chromatography on alumina (g) | (%) | Remarks |
|---|---|---|---|---|---|---|---|---|
| 1 | 200 | 40 | 2 | 0.262 | | 0.186 | 93 | Boiled for six hours. |
| 2 | 200 | 40 | 2 | 0.206 | | 0.165 | 83 | Cold extraction. |
| 3 | 2500 | 40 | 12 | 2.143 | 85.6 | | | Stirred at room temp. for 12 hours. Boiled 2 hours. |
| 4 | 1700 | 40 | 17 | 1.4378 | 85.6 | | | Boiled for 1 hour. |

In experiments 3 and 4, the residues were taken up in ether and treated as described above. When the crude alkaloid of a m.p. 140° was recrystallized from ethyl acetate, rhombic needles of m.p. 155° – 156° were obtained.

The work was carried out in collaboration with Mr. M. Zwick.

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# THE EFFECT OF VARIOUS METABOLITES ON THE ACTION OF SOME GERMINATION INHIBITORS

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The effect of some metabolites on the inhibitory action of 2,4-D and coumarin was investigated.

It was found that the carbohydrates had little effect on the action of these inhibitors. A number of amino acids (glutamic and aspartic acid and ornithine) were shown to be able to increase the inhibitory action of 2,4-D, while cystine was able to reduce it. Coumarin was not affected by amino acids apart from a stimulating effect of $\beta$ alanine.

As a result of the observations obtained in this work, a theory is suggested by which the action of 2,4-D is related to substrate accumulation and the resultant poisoning of certain enzymes. The effect of the metabolites is also related to this phenomenon. It is suggested that the metabolic process particularly affected in the germinating seed by 2,4-D is the resynthesis of proteins from the breakdown products of existing reserve materials.

Coumarin has been shown to act differently and on different metabolic paths from 2,4-D.

## I. INTRODUCTION

An investigation of certain germination inhibitors, particularly coumarin and 2,4-D (2,4-dichlorophenoxy acetic acid) shows that their action is dependent upon a very specific structure and that comparatively minor changes in them destroy their activity. A study of the literature shows that relatively little definite is known about the possible mechanism of their action[1,2]. A number of suggestions have been made as to the possible mechanism of inhibition as far as the growth of coleoptiles is concerned, but no satisfactory explanation has yet been offered to explain the inhibition of germination. It seem reasonable to suppose that inhibition of germination is a physiologically different process from the inhibition of growth. This is suggested both by the data to be described here as well as by the observations of the action of coumarin as a germination inhibitor[3] and is supported by the data of Blackman, Holly and Roberts[4]. With these considerations in mind, the present study was undertaken in order to verify in how far the addition of various substances

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known to be present in the seed or resulting from the breakdown of its storage products was able to influence the inhibitory action of these inhibitors. The substances investigated were coumarin and 2,4-D. Both inhibitors have been widely studied by a number of investigators[5,6,7,8]. 2,4-D was studied because of its great practical importance, whereas coumarin was investigated because its action is closely linked with the phenomena of light sensitivity of seeds. There is some evidence that these two inhibitors have a rather different mode of action[9], which is also borne out by the work to be described. For this reason also they provide a good comparison. Two types of seeds were investigated. Lettuce seed, of a non-light sensitive variety, and wheat. The choice here was determined by the fact that many of the normal germination features of these seeds are already known.

The metabolites studied were those connected with carbohydrate metabolism[10] which would be expected to be of particular importance in wheat and the amino acids which would be expected to be of great importance in both cases, as an undoubted process in seed germination is the breakdown and resynthesis of proteins.

## II. METHODS

The lettuce seeds were the variety Progress from the Pieters Wheeler Seed Company* and the wheat was a variety obtaintd from the settlement Kinnereth. The seeds were placed in petri dishes containing filter paper and 3 ml solution in the case of lettuce and 5 ml in the case of wheat. The petri dishes were placed in closed, light-tight boxes in an incubator or dark room at 26°C. The germination was obtained from direct counts after 48 hours. Under these conditions, the normal germination was between 90 and 100%.

The substances were investigated as follows. The seeds were germinated in the inhibitor under investigation and in the solution of the substance to be added. The inhibition obtained was determined and the sum of the inhibitors termed the calculated germination. The concentration of the metabolites added was normally chosen so as not to give any inhibition when the seeds were germinated in it alone. The calculated germination, therefore, normally represents the inhibition caused by the inhibitor itself. The inhibition was also determined when the seeds were germinated in a solution of inhibitor plus substance tested, this being termed the experimental germination.

In addition to an investigation of the metabolites on the inhibition of various inhibitors, the effect of pH on the inhibtion was also reinvestigated. This was done to ensure that any effect observed could be ascribed directly to the substances tested and was not due to any changes in the pH of the solution or of the seeds The pH measurements were made with a glass electrode, using a Beckman pH meter.

* Our thanks are due to the Pieters-Wheeler Seed Company, U.S., for supplying the lettuce seeds used for this investigation.

## III. RESULTS

In giving the results of the experiments, the work may be divided into two sections, those dealing with substances connected primarily with carbohydrate metabolism and those involving protein or more generally nitrogen metabolism.

### *A. Substances related to Carbohydrate Metabolism*

The substances investigated were sucrose, glucose, glucose-1-phosphate and ascorbic acid, each being studied on 2,4-D and coumarin, in both lettuce and wheat.

#### 1. *Experiments with* 2,4-D

(a) Lettuce

The addition of glucose to the 2,4-D leads to a marked increase in the inhibitory action of the latter. This increased inhibition rises with increasing concentrations of glucose. The same effect, but rather less marked, is observed also in sucrose (see Table I and II).

TABLE I

*Effect of glucose on inhibitory effect of 2,4-D in lettuce*

| Glucose conc. in mg % | 2,4-D conc. $\times 10^{-4}$ M | 2.25 | | 6.75 | | 9.1 | |
|---|---|---|---|---|---|---|---|
| | | % germination | | | | | |
| | | M | S.D. | M | S.D. | M | S.D. |
| 0 (calculated germination) | | 81 | 7 | 43 | 4 | 27 | 2 |
| 50 | | 80 | — | 26 | 4 | 14 | 4 |
| 100 | | 68 | 5 | 16 | 5 | 14.5 | 1.5 |
| 150 | | 39 | 17 | 6 | 5 | 0.5 | 0.5 |

M = mean; S.D. = standard deviation

TABLE II

*Effect of sucrose on inhibitory effect of 2,4-D in lettuce*

| Sucrose conc. in mg % | 2,4-D conc. $\times 10^{-4}$ M | 2.25 | | 6.75 | | 9.0 | |
|---|---|---|---|---|---|---|---|
| | | % germination | | | | | |
| | | M | S.D. | M | S.D. | M | S.D. |
| 0 (calculated germination) | | 81 | 7 | 43 | 4 | 27 | 2 |
| 50 | | 72 | 2 | 27 | 1 | 16 | 2 |
| 100 | | 74 | 1.5 | 22 | 1 | 17 | 6 |
| 150 | | 71 | 5 | 16 | 2 | 12 | 2 |

M = mean; S.D. = standard deviation

Glucose-1-phosphate when added to 2,4-D solutions leads to a marked increase in germination as compared with the controls, whereas the addition of ascorbic acid

leads to a decrease in germination, that is an accentuation of the inhibition (see Table III).

TABLE III

*Effect of glucose-1-phosphate and ascorbic acid on the inhibitory effect of 2,4-D in lettuce*

| | 2,4-D conc. $\times 10^{-4}$ M | 0.56 | | 1.12 | | 2.25 | |
|---|---|---|---|---|---|---|---|
| | | M | S.D. | M | S.D. | M | S.D. |
| Ascorbic acid 37 mg % | Calculated germ. % | 87 | 4 | 68.5 | 1.5 | 43 | 9 |
| | Experimental germ. % | 41 | 4 | 4.5 | 2.5 | 3 | 5 |
| | 2,4-D conc. $\times 10^{-4}$ M | 2.25 | | 6.75 | | 9 | |
| | | M | S.D. | M | S.D. | M | S.D. |
| Glucose-1-phosphate 150 mg % | Calculated germ. % | 56 | | 4 | 2 | 0.5 | — |
| | Experimental germ. % | 67 | | 38 | 13 | 21 | 6 |

(b) Wheat

Both glucose and sucrose caused only a very slight increase in inhibition of 2,4-D. Neither glucose-1-phosphate nor ascorbic acid had a marked effect on the inhibitory action of 2,4-D, the former slightly stimulating germination while the latter somewhat increased the inhibition (see Table IV).

TABLE IV

*Effect of ascorbic acid (75 mg %) on inhibitory effect of 2,4-D in wheat*

| 2,4-D conc. $\times 10^{-4}$ M | 2.25 | | 6.75 | | 9.0 | |
|---|---|---|---|---|---|---|
| | M | S.D. | M | S.D. | M | S.D. |
| Calculated germ. % | 87 | 0 | 80 | 0.5 | 77 | 3 |
| Experimental germ. % | 86 | 4 | 70 | 3 | 66 | 1.5 |

## 2. *Experiments with Coumarin*

(a) Lettuce

Glucose hardly affected the inhibitory action of coumarin while sucrose stimulated it slightly. Glucose-1-phosphate tended to stimulate germination while ascorbic acid caused a slightly enhanced inhibition of germination in the presence of coumarin (Table V), but this was less than in the case of 2,4-D.

TABLE V

*Effect of ascorbic acid 37.5 mg % on inhibitory action of coumarin in lettuce*

| Coumarin conc. $\times 10^{-4}$ M | 3.42 | | 5.13 | | 6.84 | |
|---|---|---|---|---|---|---|
| | M | S.D. | M | S.D. | M | S.D. |
| Calculated germ. % | 66 | 23 | 31 | 2.6 | 17 | 14 |
| Experimental germ. % | 29 | 5 | 7.5 | 6.5 | 2 | 2 |

(b) Wheat

The effect of both glucose and sucrose was not very marked in the case of wheat. The data obtained showed that glucose had no clearcut effect while sucrose had a slightly inhibitory action. Both glucose-1-phosphate and ascorbic acid stimulated germination in the presence of coumarin (see Table VI).

TABLE VI

*Effect of glucose-1-phosphate (150mg%) and ascorbic acid (75mg%) on inhibitory effect of coumarin in wheat*

| | Coumarin conc. $\times 10^{-3}$ M | 1.02 | | 1.71 | | 2.73 | |
|---|---|---|---|---|---|---|---|
| | | M | S.D. | M | S.D. | M | S.D. |
| Glucose-1-phosphate | Calculated germ. % | 70 | 7 | 36 | 8 | 3 | 0.5 |
| | Experimental germ. % | 64 | 8 | 45 | 7 | 19 | 0.5 |
| Ascorbic acid | Calculated germ. % | 74 | 6 | 47 | 0 | 4 | 6 |
| | Experimental germ. % | 87 | 5 | 60 | 6 | 39 | 12 |

It is particularly striking to note the difference in effect of ascorbic acid in conjunction with 2,4-D and with coumarin. With the former there is an increased inhibition while with coumarin the effect is not uniform, there being some stimulation in the case of wheat and slight inhibition in the case of lettuce, as is shown in Table V and VI. In addition it is remarkable that as far as the effect of glucose and sucrose could be determined, there is some inhibition in conjunction with 2,4-D, while with coumarin there was only a tendency towards inhibition or stimulation. In all cases the effects observed were recurrent but non-significant. Generally speaking all the effects were much less pronounced in wheat than in lettuce, probably due to the great size of the seeds in the former, which would presumably cause a requirement of much larger amounts of the substances tested to show any effect.

Common to both inhibitors is the fact that glucose-1-phosphate with either causes a stimulation of germination as compared with the calculated germination.

### *B. Amino acids*

The commonly occurring amino acids were systematically examined with a view to finding one or more of them which would act as antagonist to the inhibitors. Those investigated were, cystine, tyrosine, trytophane, aspartic acid, glutamic acid monohydrate, asparagine, arginine, ornithine, alanine and $\beta$ alanine, methionine, leucine, serine, glycine, lysine monohydrochloride and hydroxy proline. Cysteine was also investigated, the results having been discussed in a previous paper. The amino acids were in every case *l* or *dl*.

In all cases the amino acid concentration was 50 or 100 mg%, the 2,4-D and coumarin concentrations being varied, but so chosen that they gave alone an inhibition in the region of 50% (calculated inhibition), so that inhibition and stimula-

tion could be easily detected. The most remarkable feature of the results was that with one single exception none of the amino acids influenced germination in the presence of coumarin, while a number of them showed very marked effects in conjunction with 2,4-D.

$\beta$ alanine in lettuce in conjunction with coumarin caused a strong stimulation of germination as is seen from Table VII.

TABLE VII

*Effect of $\beta$ alanine on the inhibitory effect of coumarin on lettuce ($\beta$ alanine conc. 50mg%)*

| Coumarin conc. $\times 10^{-3}$ M | 0.68 | | 1.02 | | 1.27 | |
|---|---|---|---|---|---|---|
| | M | S.D. | M | S.D. | M | S.D. |
| Calculated germ. % | 67 | 21 | 38 | 7 | 28 | 15 |
| Experimental germ. % | 78 | 4 | 56 | 6 | 60 | 8 |

In conjunction with 2,4-D a number of the amino acids investigated added greatly to the inhibition, while some of them stimulated germination. The results of these experiments, showing the effects of cystine, aspartic acid, glutamic acid monohydrate, arginine and ornithine hydrochloride, are given in Tables VIII and IX.

TABLE VIII

*Effect of amino acids on the inhibitory effect of 2,4-D on lettuce*

| Amino acid added | 2,4-D conc. $\times 10^{-4}$ M | 2.25 | | 6.75 | | 9.0 | |
|---|---|---|---|---|---|---|---|
| | | M | S.D. | M | S.D. | M | S.D. |
| Cysteine | Calculated germ. % | 46 | 16 | 8 | 7 | 4 | 2 |
| 50 mg % | Experimental germ. % | 85 | 5 | 46 | 11 | 41 | 21 |
| | 2,4-D conc. $\times 10^{-4}$ M | 1.12 | | 2.25 | | 3.38 | |
| | | M | S.D. | M | S.D. | M | S.D. |
| Arginine | Calculated germ. % | 81 | 13 | 56 | 16 | 46 | 16 |
| 50 mg % | Experimental germ. % | 95 | 2 | 83 | 11 | 77 | 9 |
| | 2,4-D conc. $\times 10^{-4}$ M | 0.56 | | 1.12 | | 2.25 | |
| | | M | S.D. | M | S.D. | M | S.D. |
| Glutamic acid monohydrate | Calculated germ. % | 88 | 5 | 96 | 0 | 68 | 5 |
| 50 mg % | Experimental germ. % | 25 | 20 | 38 | 11 | 5 | 2 |
| Ornithine hydrochloride | Calculated germ. % | 87 | 4 | 62 | 10 | 52 | 14 |
| 50 mg % | Experimental germ. % | 27 | 20 | 8 | 8 | 4 | 6 |
| Aspartic acid | Calculated germ. % | 81 | 7 | 94 | 3 | 53 | 21 |
| 50 mg % | Experimental germ. % | 11 | 4 | 23 | 7 | 7 | 5 |

The results in the case of wheat are very similar with the exception that cystine was here ineffective and that glutamic acid only tended to cause inhibition. The results for ornithine, aspartic acid and arginine are shown in Table IX.

TABLE IX

*Effect of amino acids on the inhibitory action of 2,4-D on wheat*

| Amino acid added | 2,4-D conc. $\times 10^{-4}$ M | 2.25 | | 6.75 | | 9 | |
|---|---|---|---|---|---|---|---|
| | | M | S.D. | M | S.D. | M | S.D. |
| Aspartic acid | Calculated germ. % | 78 | 5 | 67 | 5 | 67 | 14 |
| 50 mg % | Experimental germ. % | 73 | 2 | 45 | 3.5 | 37 | 3 |
| Ornithine | Calculated germ. % | 72 | 1 | 67 | 1 | 51 | 7 |
| 100 mg % | Experimental germ. % | 48 | 4 | 29 | 1 | 7 | 3 |
| Arginine | Calculated germ. % | 72 | 1 | 67 | 1 | 52 | 7.5 |
| 100 mg % | Experimental germ. % | 62 | 3.5 | 48 | 8.5 | 55 | 4 |

It may also be noted that while arginine stimulated in lettuce, it inhibited at two of the concentrations in wheat.

In order to investigate whether the low pH of the solutions of inhibitor plus amino acid might be the cause of the effects noted, the effect of pH was investigated in the case of the amino acids of low pH. A phosphate buffer was chosen in a concentration which did not materially affect germination of the seeds but was strong enough to give buffer action against the 2,4-D plus amino acid.

In Table X some of the relevant data are recorded.

TABLE X

*The effect of pH on the inhibitory action of 2,4-D in conjunction with amino acids on lettuce seeds*

| Solution added to 2,4-D | 2,4-D conc. $\times 10^{-4}$ M | 0.56 | | 1.12 | | 2.25 | |
|---|---|---|---|---|---|---|---|
| | | | | % germination | | | |
| | pH | M | S.D. | M | S.D. | M | S.D. |
| None | 3.5 | 69 | 5 | 45 | 21 | 11 | 4 |
| Phosphate buffer | 6.85 | 61 | 12 | 20 | 10 | 5 | 4 |
| Aspartic acid 33 mg % | 2.4 | 8 | 3 | 8 | 5 | 0 | |
| Aspartic acid + buffer | 6.3 | 16 | 2 | 9 | 3 | 0 | |
| Glutamic acid 33 mg % | 2.4 | 25 | 16 | 8 | 8 | 1 | 1 |
| Glutamic acid + buffer | 6.3 | 49 | 14 | 15 | 11 | 1 | 1 |
| Ornithine hydrochloride | 2.4 | 21 | 12 | 10 | 13 | 0 | |
| Ornithine hydrochloride + buffer | 6.3 | 42 | 22 | 9 | 6 | 1 | 1 |

From the above it emerges clearly that pH is not the determining factor in the inhibition caused by the addition of amino acids to 2,4-D. It will be seen that the difference between experiments with and without buffer always lie within the experimental error and are invariably lower than the corresponding value for 2,4-D with buffer alone (which is the calculated inhibition).

An interesting observation is provided by the effect of citrate buffer on the inhibitory action of 2,4-D.

TABLE XI

*Effect of citrate buffer on the inhibitory effect of 2,4-D on lettuce seeds*

| Solution added to 2,4-D | 2,4-D conc. $\times 10^{-4}$ M | 0.56 | | 1.12 | | 2.25 | |
|---|---|---|---|---|---|---|---|
| | | | | % germination | | | |
| | pH | M | S.D. | M | S.D. | M | S.D. |
| None | 2.9 | 79 | 7 | 57 | 12 | 34 | 2 |
| Buffer | 2.4 | 0 | | 0 | | 0 | |
| Buffer | 3.2 | 21 | 6 | 1 | 2 | 0 | |
| Buffer | 5.7 | 60 | 6 | 27 | 15 | 7 | 9 |

It appears that particularly at low pH, citrate buffer can cause a greatly accentuated inhibition of 2,4-D even when the buffer itself is chosen so that it alone does not affect germination. This bears out the observation of many workers who throw doubt on the legitimacy of the use of citrate buffers in biological experiments.

It must also be pointed out here that in the absence of buffer the pH of the solutions at the end of the experiment was always in the neighbourhood of neutrality, that is pH 6.8—7.5.

All this confirms the view that pH is not the determining factor in the results quoted above.

## IV. DISCUSSION

The results obtained are chiefly remarkable for the fact that they are contrary to the theoretical expectations. The purpose of the research was to find an antagonist (competitive or otherwise) to the inhibitors investigated.

Generally speaking none of the substances markedly affected the inhibitory action of coumarin. The only clearcut effects observed were the stimulation obtained with $\beta$ alanine and with glucose-1-phosphate. It is possible that coumarin affects some stage of the fat metabolism in the lettuce seed as is indicated by the work of Poljakoff-Mayber[11]. $\beta$ alanine may well be concerned in the transamination actions which are supposed to occur during the mobilisation of fats during germination. Its stimulating effect may therefore be to reduce the interference of coumarin in such transamination reactions. It must be pointed out, however, that there is no evidence to show the exclusive function of $\beta$ alanine in such transaminations.

In conjunction with 2,4-D, as also with coumarin, glucose-1-phosphate acted as a stimulant. As glucose-1-phosphate is known to be an intermediary in respiration, its action may lead to an increase in the rate of metabolism which causes a more rapid energy release which in turn results in a faster general metabolism and consequently faster germination. There is, therefore, a competition in rates of reaction between glucose-1-phosphate and 2,4-D. The action of the former is such that the 2,4-D is not given sufficient time to act on the vital parts of metabolism which

it normally affects. The same holds also in the case of coumarin and glucose-1-phosphate.

Cystine, which stimulated in conjunction with 2,4-D, is very frequently a limiting factor in protein synthesis. Its very marked stimulatory affect may, therefore, well be due to a more rapid synthesis of proteins in the germinating seed and consequently reduced action of the 2,4-D.

Among the other amino acids, aspartic acid and ornithine gave increased inhibition both in wheat and in lettuce, while glutamic acid had this effect in lettuce only. Neither arginine nor cystine caused stimulation in wheat, the former even inhibiting. In this context the inhibitory action of ascorbic acid must also be considered. It seems obvious that no common factor or mode of action can be ascribed to these diverse substances and it is, therefore, proposed to consider each with reference to its normal function in the metabolism of the germinating seed and the plant in general.

Ascorbic acid and cystine are known to function as activators of proteases, e.g. papain. In the work here described, they appeared to function as "activators" of the inhibitor 2.4-D. Glutamic acid and ornithine are normally associated with arginine synthesis, a fact well established for example in *Neurospora,* while both aspartic and glutamic acid are concerned in the exchange of nitrogen from external sources with the ammonia of the cell, the nitrogen in them being apparently much more rapidly exchanged, as was shown for the leaves of the tobacco plant. Also both acids are rapidly deaminated with the formation of ammonia[12].

Many previous workers have ascribed to 2,4-D an action as accelerator of the metabolism in general and a consequent exhaustion of one or more metabolites. If there is such a general stimulation in the germinating seed it is difficult to understand why there should be failure to germinate. A different theory is, therefore, suggested. It is possible to envisage a process whereby there is not a general acceleration of metabolism but an acceleration of part of it. As a result of this, there would be an accumulation of some substrate in an enzymatic chain which would lead to a process resembling enzyme poisoning possibly by the irreversible formation of enzyme substrate complex and consequently a decreased general activity.

If a chain of enzymatic reactions is considered :

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C \xrightarrow{k_3} D \xrightarrow{k_4}$$

where $k$ are rates of reaction, 2.4-D may be considered to accelerate all steps up to $D$ and an accumulation of $D$ results because $k_4$ does not increase. The normal balance of the metabolites is upset as a resut of such a process.

The addition of metabolites, such a glumatic and aspartic acids, may shorten the reaction chain by providing a substrate for the reaction $B \longrightarrow C$ and therefore cutting out one step in the reaction. 2.4-D can as a result more rapidly

affect the rates $k_2$ and $k_3$, accelerating them and the accumulation of $D$ then proceeds even more rapidly. The reaction chain does not start from its normal origin and the normal rates of reactions are disturbed and a later state of the reaction is prevented from occurring. As already stated cysteine and ascorbic acid also increase the inhibition of 2,4-D. Both are known as protease activators, for example of papain and as such must accelerate an early step in protein hydrolysis which in the schematic reaction chain may be represented by A ——→B. The rate $k_1$ is, therefore, increased and once more the substrate accumulation caused by 2,4-D is accentuated.

This points to the fact that the accumulation occurs in somewhere in the resynthesis of proteins and not in their breakdown.

The theory here put forward requires further verification but it appears to allow of a unification of some of the facts known about the action both of 2,4-D and of inhibitors in general. The fact that many substances stimulate at low concentrations and inhibit at higher ones may also be explained by this theory. There may well be an optimum substrate concentration, increases above which lead to the processes outlined above. It appears that the action of 2,4-D is on the nitrogen metabolish, and possible the protein resynthesis in the germinating seed. It also emerges that courmarin has a different mode of action from 2,4-D and that different metabolic paths are involved.

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# ON THE UPPER CRETACEOUS AND LOWER TERTIARY MICROFAUNAS OF ISRAEL

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In the present note, an attempt is made to present a synopsis of the most characteristic features of the various sratigraphical units from the Santonian to the Upper Eocene, with regard to the smaller foraminifera.

The note is based on investigations carried out under the direction of Dr. M. Avnimelech in the Micropaleontological Laboratory of the Geological Institute of Israel, between October 1950 and August 1951. About 1,500 samples from surface and sub-surface formations were examined. The results of these investigations have once more proved the usefullness of smaller foraminifera for age determination and interregional correlation. The microfaunal assemblages are sufficiently characteristic in their generic, specific and numerical composition, to make fairly exact stratigraphical determinations possible. During these investigations several hundred species have been identified, many of them important time-makers over large areas. Thus it has been possible to recognize the similarities and relationship between our microfaunas and those of other regions in the Tethys-area : Europe, Africa, Asia, the Caribbean area and the Gulf Coast region, etc.

## LITHOLOGY OF THE STRATIGRAPHICAL UNITS

It seemed to us useful to give the general lithological characters of the stratigraphical units discussed below, as far as observed up to the present.

| | |
|---|---|
| Crystalline limestones; glauconitic, fine-grained limestones; soft, white, marly chalks | Upper Eocene |
| Soft, white, marly chalks; hard, yellowish-grey limestones; siliceous limestones; bituminous, dark-grey limestones (subsurface); yellowish-white, slightly limonitic chalks, with or without flints; chalks with Porifera; soft, marly chalks; marls; pyritic chalks and marls (mostly subsurface) | Lower + Middle Eocene |
| Grey chalks; partly silicified limestones; soft, white, whitish-grey, greenish-grey, greenish-yellow or yellow chalks and marls, often strongly limonitic (surface) or pyritic (subsurface); glauconitic chalks and marls; slightly bituminous chalks and marls (mostly subsurface); occasionally sandy chalks and marls (in the south) | Paleocene Danian- |

| | |
|---|---|
| Yellowish-white or yellow chalks and marls, limonitic, frequently strongly so; strongly glauconitic chalks; limonitic chalks with Porifera; red or reddish-brown, hard limestones ("Mottled Zone"?) greenish-yellow to bright grey marly chalks and marls (mostly Negev); slightly bituminous, pyritic chalks and marls (subsurface); occasionally sandy chalks and marls (in the south) | Maestrichtian |
| White, slightly limonitic chalks or marly chalks and marls; dark-grey, bituminous limestones, chalks and marls; chalks and phosphatic or phosphatized chalks with flint bands; white and pinkish-white limestones and chalks; hard, yellowish-grey to reddish-brown limestones ("Ka'akuhle") | Campanian<br>Santonian- |

## 1. UPPER CRETACEOUS

The samples examined from the Upper Cretaceous are mostly from post-Turonian strata, since pre-Senonian material is usually too hard to be washed and must be examined in thin sections. This method, used successfully in examinations of larger foraminifera, is usually of little value for specific or even generic identification of smaller foraminifera, with the exception of a few arenaceous and calcareous groups. Thus, for example, median and axial sections through the tests of specimens belonging to the genus *Globotruncana,* reveal details, which are in most cases sufficiently characteristic for specific identification.

The few samples examined from soft strata of Cenomanian age of the Carmel and the Jerusalem area do not yet make it possible to draw any conclusion on the general characteristics of microforaminiferal assemblages of Cenomanian age in Israel, since these samples have either yielded no microfauna at all or a microfauna very poor in species and specimens, as far as the smaller foraminifera are concerned.

Hard limestones of Turonian age (the so-called "Mizzi hilu") are very rich in microforaminifera, but we have hitherto not succeeded in separating microorganisms from these limestones, due to their remarkable hardness. Further study is required on these limestones, since it is suspected that they are partly of Lower Senonian age. This suspicion arises since thin sections of these limestones revealed very different microfaunal associations, although no distinct lithological difference could be observed. Generally three types of "Mizzi hilu" can be distinguished from the microfaunistic point of view: strata very poor in fossils, containing rare and usually distorted microforaminifera; strata very rich in foraminifera (mostly Miliolidae and some arenaceous forms); and strata bearing a *Globotruncana-Globigerina-Gümbelina* assemblage (*Globotruncana* of the *G.lapparenti* Brotzen group, rare and doubtfull specimens of *G.fornicata* Plummer, *Globigerina* cf. *cretacea* d'Orb., *Gümbelinae* of the *G.globulosa* (Ehrb.)-*G.striata* (Ehrb.) group, furthermore "rotaliform" species,

etc. The possibility is not excluded that these latter strata belong already to the Senonian (Coniacian?). *)

Rich and easily separated microforaminiferal assemblages are usually found in Senonian strata. We shall distinguish for the time being two main divisions of Upper Cretaceous post-Turonian strata:

a. Santonian-Campanian and
b. Maestrichtian.

The uppermost Cretaceous (Danian) is here treated together with the Paleocene.

### *a. Santonian-Campanian*

There are two main reasons for presenting the Santonian and the Campanian in a single complex: in the first place these sub-stages have not yet been satisfactorily defined in terms of macrofossils in our country; secondly, a separation between these sub-stages has not yet been carried out in a satisfactory manner in terms of foraminifera either in the Mediterranean area or even in the Western Hemisphere.

The Santonian-Campanian of Israel is characterized by the abundance of Gümbelinidae and Globigerinidae and by the relative high frequency of Globorotaliidae. Very frequent are also the Lagenidae and in higher parts of the section the Discorbinae and Anomalininae. The Buliminidae are occasionally frequent. The arenaceous smaller foraminfera are rather rare in the lower part of this complex, becoming more frequent in the middle and upper part of it. Occasionally the highest layers of this complex are very poor in pelagic species, the microforaminiferal assemblages being characterized chiefly by Lagenidae, Discorbinae and Anomalininae.

Characteristic members of the Santonian-Campanian microforaminiferal assemblages are: *Spiroplectammina laevis* (Roemer) var. *cretosa* Cushman, *Gaudryina rugosa* d'Orb., *Dorothia glabrella* Cushman, *Clavulinoides* sp., various species of *Nodosaria* (N.group of *affinis* Reuss), *Lenticulina, Robulus, Marginulina,* (among them *M. bullata* Reuss), *Saracenaria* (*S.triangularis* (d'Orb.)), *Frondicularia, Palmula suturalis* Cushman, higher in the section *Palmula rugosa* (d'Orb.), very rare *Palmula* cf. *primitiva* Cushman in the basal layers of this complex, *Kyphopyxa christneri* (Carsey), *Bulimina reussi* Morrow, *Bulimina prolixa* Cushman & Parker, high in the section rare *B.kickapooensis* Cole, also in the uper part of this complex *Buliminella carseyae* Plummer and in the lowermost part *Neobulimina* cf. *irregularis* Cushman & Parker. Very small specimens of *Virgulina* sp. are occasionally frequent. Rare are the species of *Bolivinoides*. In the uper part of the section very rare *B.decorata* (Jones)

* Of interest for the problem of the Turonian-Senonian boundary in Israel is an occurrence of a *Hippurites*, identified by G. Astre[1] as belonging to *H.(Orbignya) praetoucasi* Toucas, in white, compact and crystalline limestone in the vicinity of El Kubab (S.-E. of Lydda). Astre arrives at the conclusion that the strata from which the above mentioned *Hippurites* originates, are of uppermost Turonian lower Coniacian age, with distinct paleontological affinities with the Coniacian, although he admits that the specimen examined by him is an ancestral form of the typical coniacian *H.praetoucasi*. Possibly these strata represent both the uppermost Turonian and the lowermost Senonian (see Avnimelech[2] (. 32)).

and in the uppermost part of this complex *B.decorata* (Jones) var. *delicatula* Cushman are encountered. In the highest strata of the Santonian-Campanian complex *Loxostoma gemmum* (Cushman) is encountered. Relatively frequent are species of *Gyroidina* and *Gyroidinoides* (*G.depressa* (Alth), *Gyroidinoides nitida* (Reuss), *Gyroidinoides* nov.sp.*) – a guide fossil for the upper part of the complex –, *Gyroidina* cf. *globosa* (Hag), etc. In the lower part of this complex *Valvulineria* cf. *lenticula* (Reuss) is a characteristic species. *Quadrimorphina allomorphinoides* (Reuss) is encountered throughout the complex, but rather rarely. In the upper part of the section a characteristic, hitherto not identified species of *Eponides* occurs (apparently related to *E.biconvexa* Marie), furthermore rather rare specimens of *Parrella cordieriana* (d'Orb.). The Anomalininae are represented by several species of *Anomalina* (e.g. *A.clementiana* (d'Orb.)), *Planulina* (among them *P.taylorensis* (Carsey)), and *Cibicides*, especially in the upper part of the complex, where *C.semicomplanata* (Cushman & Hedberg) (non Cushman) occurs very frequently, and in the uppermost strata by *C.voltziana* (d'Orb.), *C.abudurbensis* Nakkady (but flatter then the typical Maestrichian form), etc. *C.beaumontiana* (d'Orb.) occurs rarely in the upper part of the complex.

As already pointed out, the Globigerinidae are usually abundant in Santonian-Campanian strata. They are represented chiefly by *Globigerina cretacea* d'Orb. and *Globigerinella aspera* (Ehrenberg). The Globorotaliidae are represented by various species of *Globotruncana* and *Globorotalites*. Charateristic species are *Globotruncana ventricosa* (White), *G.lapparenti lapparenti* Bolli, *G.lapparenti bulloides* Vogler, *G.lapparenti tricarinata* (Quereau), *G.fornicata* Plummer, *G.arca* (Cushman) (rare), *G.cretacea* Cushman, *G.rosetta* (Carsey), etc. In the highest layers of this complex rare *G.stuarti* (De Lapparent) are encountered. *Globorotalites subconica* (Morrow) is characteristic for the lower part of this complex and in the highest portion of it, *Globorotalites* sp. occurs (apparently closely related to *G.micheliniana* (d'Orb.)). — The genus *Gümbelina* is represented by *G.globulosa* (Ehrenberg), *G.striata* (Ehrenberg), rather rare *G.plummerae* Loetterle, very rare *G.carinata* Cushman, etc. — *Pseudotextularia eggeri* (Cushman) is encountered in the middle and upper part of this complex.

### *b. Maestrichtian*

There appears to be a distinct difference from the micropaleontological point of view between the Santonian-Campanian and the Maestrichtian. This difference is due to both the composition of the assemblages and the frequency of species or even genera. Many species, characteristic in the Santonian-Campanian, have completely disappeared or are greatly reduced numerically and several characteristic species make their appearence in the Maestrichtian, among them guide-species for this age in Europe, Africa, Asia and America.

* The desrcription of this species and of another new species mentioned in this note will be published in a further paper.

The microforaminiferal assemblages of Maestrichtian age of Israel are characterized chiefly by the abundance of large and strongly ornamented Gümbelinidae, by the high frequency of the Bolivininae and by the relative high frequency of Discorbidae. Characteristic members of these assemblages are also the *Buliminae* and *Buliminellae*. Generally the fauna of the Maestrichtian is much more varied than that of the Santonian-Campanian. The following may be said on the characteristic forms occurring in the Maestrichtian :

The arenaceous smaller foraminifera are represented by various species of *Gaudryina,* (*G.* (*Pseudog.*) *pyramidata* Cushm.) *Clavulinoides, Ataxophragmium, Heterostomella,* etc. to which rather rare *Spiroplectammina laevis* (Roemer) var. *cretosa* Cusman should be added (lower part of Maestrichtian). *Marssonella* sp., et. al. The Lagenidae show generally a numerical decrease. The species of *Frondicularia,* which occur fairly frequently in the Santonian-Campanian, do not occur any more in the Maestrichtian, where only rare specimens belonging to this genus are found. The most important species of the Lagenidae is *Palmula reticulata* (Reuss), which occurs associated with *P.rugosa* (d'Orb.) and in higher strata with *P.jarvisi* (Cushman) The Polymorphinidae are represented by rather rare *Globulina* sp., *Pyrulina* sp. and *Ramulina aculeata* Wright. The Buliminidae are representd by *Buliminella carseyae* Plumer, *B.laevis* (Beissel) (frequent), *Bulimina reussi* Morrow, *B.prolixa* Cushman & Parker, *B.kickapooensis* Cole (frequent), *B.aspera* Cushman & Parker, etc.; by specimens of *Pseudouvigerina cristata* (Marrson), *Eouvigerina* sp. (apparently identical with a species described from the Chalk with *Belemnitella mucronata* of the Paris Basin), furthermore by *Bolivinitella eleyi* (Cushman) and by very rare *Bolivinita selmensis* Cushman (only in the uppermost part of the Maestrichtian): characteristic members of this group are: *Bolivina incrassata* Reuss, *B.decurrens* (Ehrb.) Marsson, *Loxostoma limonense* (Cushman), *Bolivinoides draco* (Marsson), *B.decorata* (Jones) var. *delicatula* Cushman. Other characteristic forms are frequently occurring *Quadrimorphina allomorphinoides* (Reuss), *Valvulineria* cf. *V. laevis* Brotzen, *Gyroidina globosa* (Hagenow), *Gyroidinoides nitida* (Reuss) (rare), *Eponides* sp., *Stensiöina pommerana* Brotzen, *Parrella cordieriana* (d'Orb.), *Parrella lens* (Brotzen) (rare in the uper part of the Maestrichtian), furthermore *Pseudovalvulineria gracilis* (Marsson) *Pseudovalvulineria* sp. (hitherto not identified, but according to Dr. F. Brotzen (personal communication) occurring in Scandinavia), *Gavelinella costata* Brotzen, etc. — Frequent and characteristic species from the Anomalininae are: *Cibicides voltziana* (d'Orb.), *Cibicides abudurbensis* Nakkady, *C.beaumontiana* (d'Orb.), *Cibicides* (*Cibicidoides*) *constricta* (Hagenow), *Anomalina pseudoacuta* Nakkady (higher strata of the Maestrichtian), in the lower part of the Maestrichtian *Cibicides semicomplanata* (Cushman & Hedberg), etc. From the Globigerinidae *Globigerina cretacea* (d'Orb), characteristic *G.rugosa* Plummer and *Globigerinella aspera* (Ehrenberg) are encountered. The species of *Globotruncana* occurring in the Maestrichtian are chiefly the same as in the Santonian-Campanian, as-

sociated with characteristic Maestrichtian species, such as *G.stuarti* (De Lapparent), *G.contusa* Cushman, *G.aegyptiaca* Nakkady, etc. These latter species characterize the Maestrichtian up to its top, while the species belonging to the group of *G.lapparenti* Brotzen, *G.fornicata,* etc. disappear during the Maestrichtian. Rare in the Maestrichtian is *Globotruncana conica* White. *Globorotalites* sp., which occurs in the uppermost Santonian-Campanian, is very frequent and characteristic for the Maestrichtian. The Gümbelinidae are represented by various species of *Gümbelina* and *Pseudotextularia.* Characteristic members of this group are *Gümbelina excolata* Cushman, *G.costulata* Cushman, *G.globulosa* (Ehrenberg). *G.striata* (Ehernberg) and in the lower part of the Maestrichtian *Gümbelina plummerae* Loetterle. Frequent and characteristic are specimens of *Pseudotextularia elegans* Rzehak.

Except the smaller foraminifera, several groups of other microfossils are noteworthy in the Senonian-Maestrichtian : The Ostracoda are very frequent in the Santonian-Campanian, less so in the Maestrichtian. They belong mostly to ornamented species. Coprolithes are encountered in the Santonian-Campanian, mostly associated with phosphatic layers. Echinoid-spines are occasionally frequent in the Santonian-Campanian, but almost absent in the Maestrichtian. Fish-remains occur in the Santonian-Campanian mostly in phosphatic layers, but are encountered also in the Maestrichtian.

As may be seen from the lithological characters of the various stratigraphical units, mentioned earlier in this note, the so-called "Maestrichtian Flint" has been observed hitherto only in the complex, interpreted on a microfaunistic basis as Santonian-Campanian, in the areas investigated up to now. Conclusions can not be drawn with regard to eastern regions (e.g. Judean Desert) where two flint horizons are distinguished : one belonging to the Maestrichtian, the other to the Campanian (see Picard)[3]. As far as observed up to now, it seems that an error in the interpretation of the Senonian and "Danian" is the cause for regarding the Senonian flint-beds as belonging to the Maestrichtian. This suspicion arises, since strata, designated in the field as so-called "Danian" (such as strongly limonitic limestones or chalks) have been shown to carry typical Maestrictian fauna and only fairly high above these strata, the characteristic Danian-Paleocene fauna appears. The possibility that such "Danian" or "Paleocene" strata should carry Maestrichtian fauna (not redeposited) and be of younger than Maestrichtian age must obviously be excluded, since we would have to agree in this case that such typical Cretaceous (the Danian exclusive) genera as *Globotruncana* or *Pseudotextularia* had survived in Israel together with a whole series of typical Maestrichtian species after the close of the Maestrichtian, a matter which appears highly improbable, considering the thousands of records up to now.—

## 2. DANIAN-PALEOCENE

The reasons for treating these strata provisionally as a single complex are well known. Neither in the Eastern, nor in the Western Hemisphere has the problem of the Cretaceous-Tertiary boundary been satisfactorily settled and the opinions whe-

ther the one or the other formation should be regarded as Danian or as Paleocene vary sometimes considerably. The difficulty, at the present time, of defining either the Danian or the Paleocene with sufficient precision, makes long-range interregional correlation of these stratigraphical units doubtfull and therefore they are included for the time being in a single complex.

Within this Danian-Paleocene complex two main divisions may be distinguished : a lower part, characterized by abundant *Globigerinae* and Discorbidae and an upper part characterized mainly by the abundance of *Globigerinae* and *Globorotaliae*. Although many species, known already from the Maestrichtian, occur also in the Danian-Paleocene, especially in the lower part of it, none of the most characteristic species and even genera of the Maestrichtian are encountered any more in this complex. They include all species of *Globotruncana, Pseudotextularia,* ornamented *Gümbelinae,* furthermore *Palmula reticulata, Bolivinoides draco, Bolivina incrassata, Globigerina rugosa,* etc. The lower part of this complex shows distinct Cretaceous affinities, while the assemblages of the upper part of it bear a Tertiary character. Many species, which appear in the Danian-Paleocene continue higher into the Eocene. Nevertheless a whole series of characteristic species seem to be restricted to the Danian-Paleocene and thus this complex is well characterized by both negative and positive evidence.

Characteristic members of the Danian-Paleocene assemblages are among others : *Spiroplectammina* cf. *S.carinata* (d'Orb.) *Gaudryina* (*Pseudogaudryina*) *pyramidata* Cushman, *Gaudryina* (*Siphogaudryina*)*aissana* ten Dam & Sigal, *Marssonella* cf. *oxycona* (Reuss), furthermore rather rare *Spiroplectammina* cf. *S.grzybowskii* Frizzell, *Clavulinoides* sp., *Vulvulina* cf. *V.colei* Cushman, etc.; *Nodosaria* gr. of *N.affinis* (Reuss), *N.velascoensis* Cushman, *Palmula jarvisi* (Cushman), *Guttulina* sp., *Ramulina aculeata* Wright, *Bulimina* (*Desinobulimina*) *quadrata* Plummer, *Bulimina cacumenata* Cushman & Parker, *Bolivinita selmensis* Cushman, *Bolivina midwayensis* Cushman *Loxostoma applinae* (Plummer), *Loxostama limonense* (Cushman), *Bolivinoides decorata* (Jones) var. *delicatula* Cushman (only in the lower part, frequent), *Pleurostomella* sp., *Spirillina* sp. (lower part), *Quadrimorphina allomorphinoides* (Reuss), *Pseudovalvulineria* sp. (occurring in the upper part of the Maestrichtian), *Pseudovalvulineria* nov.sp. (a guide-fossil for these strata), *Gyroidina globosa* (Hagenow), *G.depressa* (Alth), *G.girardana* (Reuss), *Eponides trümpyi* Nuttall, *E.umbonata* (Reuss), *Alabamina midwayensis* Brotzen, *A.wilcoxensis* Toulmin, *Parrella lens* (Brotzen), *Cibicides voltziana* (d'Orb.), *C.*(*Cibicidoides*) *constricta* (Hagenow), *C.beaumontiana* (d'Orb), *C.abudurbensis* Nakkady, *Anomalinoides danica* (Brotzen), *Anomalinoides vanbelleni* ten Dam & Sigal, *Anomalina pseudoacuta* Nakkady, *Globigerina pseudobulloides* Plummer, *G.triloculinides* Plummer, *G.compressa* Plummer, *Globorotalia membranacea* (Ehrb.) Cushman, *G.velascoensis* (Cushman), *G.crassata* (Cushman) var. *aequa* Cushman & Renz, *G.simulatilis* (Schwager), *G.*cf.*G.wilcoxensis* Cushman & Ponton, etc. Occasionally specimens of *Chilostomelloides* sp. are frequent. *Allomorphina conica* (Cushman &

Todd), (given in the attached table as *Eggerella trochoides* (Reuss)), encountered rarely in the Maestrichtian, is somewhat more frequent in the Danian-Paleocene complex.

The Ostracoda are extremely rare; fish remains are often found in these strata.

### 3. EOCENE

For the time being, the Eocene is treated in two main divisions:

a. Lower and Middle Eocene and

b. Upper Eocene.

A satisfactory boundary between the Lower and the Middle Eocene must await a closer investigation of the larger foraminifera and other macrofossils of these strata.

The general characteristic of the Eocene microforaminiferal assemblages consists chiefly in the abundance of pelagic foraminifera, belonging to the Globigerinidae and Globorotaliidae. The survivors of the Cretaceous species which occurred in the Danian-Paleocene, have completely disappeared; on the other hand almost none of the characteristic species of the Oligo-Micocene has yet made appearence. In connection with the pelagic Eocene foraminifera, reference is made to a recently published paper by Grimsdale[4].

#### *a. Lower and Middle Eocene*

As already pointed out, the most characteristic species in these strata belong to the Globigerinidae and Globorotaliidae. The areanaceous foraminifera are rather rare and are represented by *Spiroplectammina* sp., *Dorothia eocenica* Cushman, *D.principensis* Cushm. & Bermudez, *Vulvulina* sp., etc. Very rare Miliolidae are occasionally encountered. Rare are also the Lagenidae (mostly *Robulus* and *Lenticulina* spp.). The Bulimininae occur in rather small numbers: *B.tarda* Parker & Bermudez, *B.truncanella* Finlay, *B.serratospina* Finlay, *B.stalacta* Cushman & Parker, rather rare *Buliminella grata* Parker & Bermudez, etc.— Very frequent are the *Uvigerinae*, especially higher in the section. The *Bolivinae* are generally rare. *Bolivinita selmensis* Cushman occurs in the lowest part of this complex. A characteristic form is *Bolivina aragonensis* (Nuttall). Other important species belonging to this group are *Bifarina nuttalli* Cushman & Siegfus, *Siphogenerina* sp., *Angulogerina* sp. Characteristic members of these assemblages are the species of *Cassidulina* belonging mostly to the group of *C.subglobosa* Brady. Other characteristic species are *Valvulineria* sp., *Eponides trümpyi* Nuttall, *E.umbonata* (Reuss), *Parrella mexicana* (Cole), *Cibicides cushmani* Nuttall, *C.perlucida* Nutall, *C.pseudoconoidea* Cita, *Anomalina dorri* Cole var. *aragonensis* Nuttall, furthermore in the lower part of this complex *Alabamina wilcoxensis* Toulmin. The Globigerinidae are represented by various species of *Globigerina, Globigerinella, Globigerinoides* and *Hantkenina*. The *Globigerinoides* and *Hantkenina* appear in the upper part of this complex.

Characteristic members of these assemblages are: *Globigerina triloculinoides* Plummer (lower part), *G.bulloides* d'Orb., *G.cocaenica* Terq., *Globigerinoides triloba*

(Reuss) (?), *Globigerinoides orbiformis* (Cole), *G.mexicanus* (Cushman), *Globigerinella? micra* (Cole), *Hantkenina mexicana* Cushman, *H.dumblei* Weinzierl & Applin, *H.* cf. *H.liebusi* Shokhina. The specimens of *Hastigerinella* (*H.eocaenica* Nuttall?) are very rare. Useful for stratigraphical determinations are the species of *Globorotalia*. Characteristic are: *Globorotalia simulatilis* (Schwager) (lower part of the complex), *G.wilcoxensis* Cushman & Ponton, *Globorotalia sp.* (*G.*aff.*globigeriniformis* Van Bellen of Grimsdale?), *G.*group of *G.crassata* (Cushman), *G.topilensis* Cushman, *G.aragonensis* Nuttall, *G.aragonensis* Nuttall var. *caucasica* Glaessner, *G.lehneri* Cushman & Jarvis, *G.centralis* Cushman & Bermudez, etc. —

From the other microorganisms, the Radiolaria are doubless the most characteristic group in the Lower+Middle Eocene complex. They often occur in masses ("floods"). Ostracoda occur sporadically and are fairly rare. Porifera spicules are found in hard limestones, belonging mostly to Silicispongiae.

The state of preservation of microforaminiferal assemblages of Lower+Middle Eocene age is often very bad, sometimes to such an extent that specific or even generic identification is almost impossible. Eocene material is often too hard to be washed and must be examined in thin sections which, however, may reveal important larger foraminifera, such as *Bathysiphon*, *Alveolina*, *Nummulites*, *Discocyclina*, etc.

### *b. Upper Eocene*

The general picture obtained from microfaunal examination of Upper Eocene material is in many respects distinct from that offered by Lower—Middle Eocene assemblages. All keeled *Globorotaliae* have disappeared and mostly rounded, *Globigerina*-like forms occur. Generally the *Globorotaliae* show a numerical decrease. The Discorbidae are more frequent and the Buliminidae are represented by many species of *Bulimina*, *Uvigerina*, *Bolivina*, etc. Occasionally frequent are also various species of *Ellipsonodosaria* and *Siphonodosaria* and *Gümbelina* sp.

The arenaceous foraminifera, which are more frequent than in the Lower+Middle Eocene, are represented by species of *Textularia*, *Spiroplectammina* (*S.carinata* (d'Orb.)), *Vulvulina*, *Clavulinoides*, etc. Lagenidae and Polymorphinidae are frequent. *Eponides umbonata*, *E.trümpyi*, *Parrella mexicana*, *Cibicides cushmani*, etc. are encountered also in the Upper Eocene. The Globigerinidae occur abundantly. Characteristic members are *Globigerina dissimils* Cushman & Bermudez, *Globigerinoides mexicanus* (Cushman, *Globigerinoides index* Finlay, *Globigerinella micra* (Cole), *Hantkenina alabamensis* Cushman, *H.dumblei* Weinzierl & Applin (lower part) etc. From the *Globorotaliae*, *G.centralis* Cushman & Bermudez and *G.cerroazulensis* (Cole) are characteristic forms. Only a very few samples from the U. Eocene have been examined up to now and more study is needed on these rich foraminiferal assemblages. —

The Radiolaria are much less frequent than in the underlying Lower+Middle Eocene complex, but fish remains and Ostracoda often occur.

## GENERAL REMARKS

It should be emphasized that the stratigraphical conclusions, as presented in this note, are entirely based on interregional correlation by means of smaller foraminifera. Although this procedure might present some "dangers" it is in our opinion highly justified, as pointed out repeatedly by various micropaleontologists. In many cases, when macrofossolis were lacking or not sufficiently characteristic to facilitate the dating of a certain deposit, foraminifera have proved to be the only reliable factor on which the stratigraphy could be based. Micropaleontological investigations have in many instances revealed errors in stratigraphical or structural interpretations, based on lithology or uncharacteristic macrofossils. A long-range interregional correlation is, however, far from being definitely settled. Many problems have to be solved, before we shall be able to proceed with exact age determination by means of interregional correlation of microforaminiferal assemblages. The differences of opinion between the various micropaleontologists on many problems (of stratigraphical and systematical nature) is yet too great to make the drawing of definite conclusions in every case possible. Doubtless the problem of the Cretaceous-Tertiary boundary is one of the most difficult facing the micropaleontologist, but also Senonian or Eocene deposits in the Western Hemisphere have not yet been entirely satisfactorily correlated with the West-European time scale, or even with dated deposits in the Americo-Caribbean area. Well-known examples are the deposits in the Tampico Embayment and in Trinidad. The sequence San Felipe, Papagallos, Mendez, Velasco, Chicontepec in Mexico has been already interpreted in various manners. The correlation of the Velasco shale with the Navarro of Texas has placed repeatedly the Mendez shale in the Campanian (or Santonian) and Thalmann[5], assigning a Paleocene age to the Velasco shale, assumed a discontinuity between the Santonian and the Paleocene during the Laramic phase of folding in the Tampico Embayment. There seems to be, however, little doubt that the Mendez formation represents the Maestrichtian and the correlation of the Papagallos with the Campanian appears most likely. Although several authors regard at present the Velasco shale as being of Paleocene age, we share the opinion of many micropaleontologists, who place at least part of this formation in the Upper Cretaceous (Danian). The same is true for the Lizard Springs formation in Trinidad. The Midway group of the Gulf Coast region and of the Carribbean area has been regarded as being entirely of Paleocene age. Scott (1934) compared this formation with the Danian of Europe and Brotzen[6] correlated the Lower Midway definitely with the Upper Danian "Crania limestones" and "Limesands of Klagshamn" in Scandinavia, thus placing the Upper Midway in the Lower Paleocene and the Lower Wilcox formation in the Upper Paleocene. A Paleocene age for the Wilcox formation (or part of it) has been suggested among others also by Glaessner[7]. The correlation of the Wilcox formation with the European time-scale is of great importance for the interpretation of the "Libyan stage"

in Africa, which has many species in common with the Wilcox formation. The problems connected with the so-called "Dano-Montian" of North Africa are also not yet finally settled. The differences of opinion regarding the age of formations between the Maestrichtian and the Eocene proper, have even lead to such proposals as the creation of an independent system — the "Creocene" (Rama Rao)[8] — for the "transition beds" between the Maestrichtian and the Thanetian. As already pointed out, the Senonian formations in the Western Hemisphere are also not yet definitely correlated with the European time-scale. The Austin formation, for example, has been regarded as representing the Coniacian and Lower Santonian, subsequently as representing only the Coniacian and lately as representing the Coniacian and Santonian, thus placing the Taylor formation entirely in the Campanian.

Despite these difficulties general agreement has been reached on many important points, e.g. the Maestrichtian-Danian boundary. The disappearence of *Globotruncana, Pseudotextularia,* etc. marks the end of the Maestrichtian all over the world. Many guide-fossils among the foraminifera have proved to be of the greatest value for exact age determination. An example of this is *Palmula reticulata* (Reuss) which has been found hitherto only in strata of unquestionable Maestrichtian age in both the Eastern and the Western Hemisphere. These facts are also the reason why certain stratigraphical interpretations of various deposits of Israel can not be maintained and must be revised on the basis of micropaleontological evidence.

The difficulties arising from problems of nomenclature are also well-known. The errection of new species, although the differences between them and already known species appear to be to small, to be of specific or even varietal value, has caused and causes much trouble to workers on foraminifera, especially to those working on "Terra incognita". — A classical example is *Bolivinoides rhomboidea* (Cushman). We agree with White, Marie, Hiltermann, et. al. that this species is identical with *Bolivinoides draco* (Marsson). Different interpretations of various species (or genera) lead to wrong conclusions about the geographical distribution of the species concerned. *Kyphopyxa christneri* (Carsey) may serve as an example. To the author's knowledge this species has been recorded hitherto only from strata of Austin and Taylor age of the Gulf Coast region and of the Caribbean area. Cushman even expressed his opinion that the genus *Kyphopyxa* is restricted to the American area. *K.christneri* has been found in many samples of Santonian-Campanian age of Israel and, therefore, the area of its geographical distribution must be far larger than the American area. A well-known subject of dispute is the already notorious specimen of *Globotruncana arca* Cushm. (figured by Cushman in 1932[9] (pl. 15, fig. 13; see also: U.S. Geol. Surv. Prof. Paper 206, pl. 62, fig. 5 (1946)). This specimen has been regarded by various authors as representing *G.stuarti* (De Lapp.) by others as representing *G.rosetta* (Carsey). We agree with many authors who refuse to regard this specimen as *G.stuarti*, since we share the opinion that it represents a typical *G.rosetta*. Nevertheless Bolli[10] again includes this specimen in the synonymy of *G.*

*stuarti*. Although, as pointed out, this is wrong in our opinion, Bolli fortunately figures a specimen of *G.stuarti* from Trinidad, which doubtless represents this species. This throws some light on the geographical distribution of *G.stuarti*. This species has been regarded as being restricted to the Eastern Hemisphere, but it has been recorded later from Trinidad as *G.arca* (see : Cushman & Renz[11]). The opinions regarding this record from Trinidad were still devided, part of the micropaleontologists regarding the specimen figured by Cushman and Renz as a *G.rosetta*. Bolli's record from Trinidad leaves little doubt about the fact that *G.stuarti* occurs in the Caribbean area. It remains, however, questionable, whether this species occurs in the Gulf Coast region or not.

The problems arising from the synonymy of *Pseudotextularia elegans* Rzehak and many other species are also well known. — A lengthy discussion of these problems would be beyond the purpose of the present note. We share, however, the opinion that the world-wide distribution of many species, their stratigraphical range as recorded (and checked) in hundred of investigations, constitute a good basis for age determination by means of interregional correlation, based on smaller foraminifera.

As may be seen from the previous chapters, our Senonian-Eocene microfaunas (although only a few species have been recorded here) show a distinct relationship with the microfaunas of similar age of both the Eastern and Western Hemisphere. The similarities between the microforaminiferal assemblages in the whole Tethyan area has been repeatedly emphasized by many paleontologists. It is a well-known fact that most of the species of smaller foraminifera occurring in Europe are found in the Gulf Coast region and in the Caribbean area, also in California and occur in North Africa, in the Middle East, in the Caucasus-Caspian Sea region (including the Emba region and the Ust Urt), in Central Asia and as far as in the East Indies. Many species occur in Australia and in New Zealand. Our Santonian-Campanian microfauna is very similar to those recorded from strata of Santonian and Campanian age of Europe, Africa and Asia, from strata of Austin and Taylor age of the Gulf Coast region and of the Caribbean area. The species occurring in our Maestrichtian are characteristic of the European Maestrichtian, of that of North Africa, of the Middle East countries, of the Caucasus-Caspian Sea region, East Indies, etc., of strata of Navarro age in the Gulf Coast region and in the Caribbean area. Our Danian-Paleocene complex bears a microfauna closely related to that of the Velasco-shale of Mexico, of the Lizard Springs marls in Trinidad, of the Midway formation and its equivalents in the Gulf Coast region and in the Caribbean area, partly to that of Lower Wilcox age in the same region, of the European Danian and Paleocene, of the Danian and Paleocene of the Caucasus region (Ilchidag, "Pecten-Horizon", Gorjatshij Kljutsh beds, etc.), of the Uppermost Cretaceous of Cyprus, of the Danian and Paleocene of North Africa (Esna-shales, Dano-Montian), etc. The Lower+Middle Eocene complex bears many characteristic species occurring in strata of similar age in Europe, Africa, Asia, in the Wilcox and Clai-

borne formations and their equivalents in the American area, in the Aragon formation of Mexico and its equivalents in the Caribbean area, etc. Characteristic microforaminifera from the Upper Eocene of Israel in strata of Priabonian (Bartonian) age in Europe, Africa and Asia and are characteristic of strata of Jackson age in the Gulf Coast region and in the Caribbean area.

The accompanying preliminary distribution chart shows the stratigraphical distribution of some charateristic species of smaller foraminifera as observed up to now in Israel. Although it is somewhat schematical and includes only a very few species, the chart may give a picture of the characteristics of microforaminiferal assemblages in the respective stratigraphical units.

ACKNOWLEDGEMENT

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A list of publications used during our investigations would scarcely fit into the framework of the present note. Only those works to which special reference is made here are quoted below. — Other works consulted include, besides the Catalogue of Foraminifera by Ellis and Messina, publications by Bermudez, Bolli, Bronnimann, Brotzen, Cita, Cushman, ten Dam, Glaessner, Henson, Hiltermann, Keijzer, Kikoine, Marie, Mornod, Nakkady, Ostrowski, Plummer, H. H. Renz, C. Renz, Reichel, Thalmann, Tromp, Van Wessem, Wicher, etc. For Palestinian geology the works of Avnimelech, Blake, Picard, et. al. were consulted.

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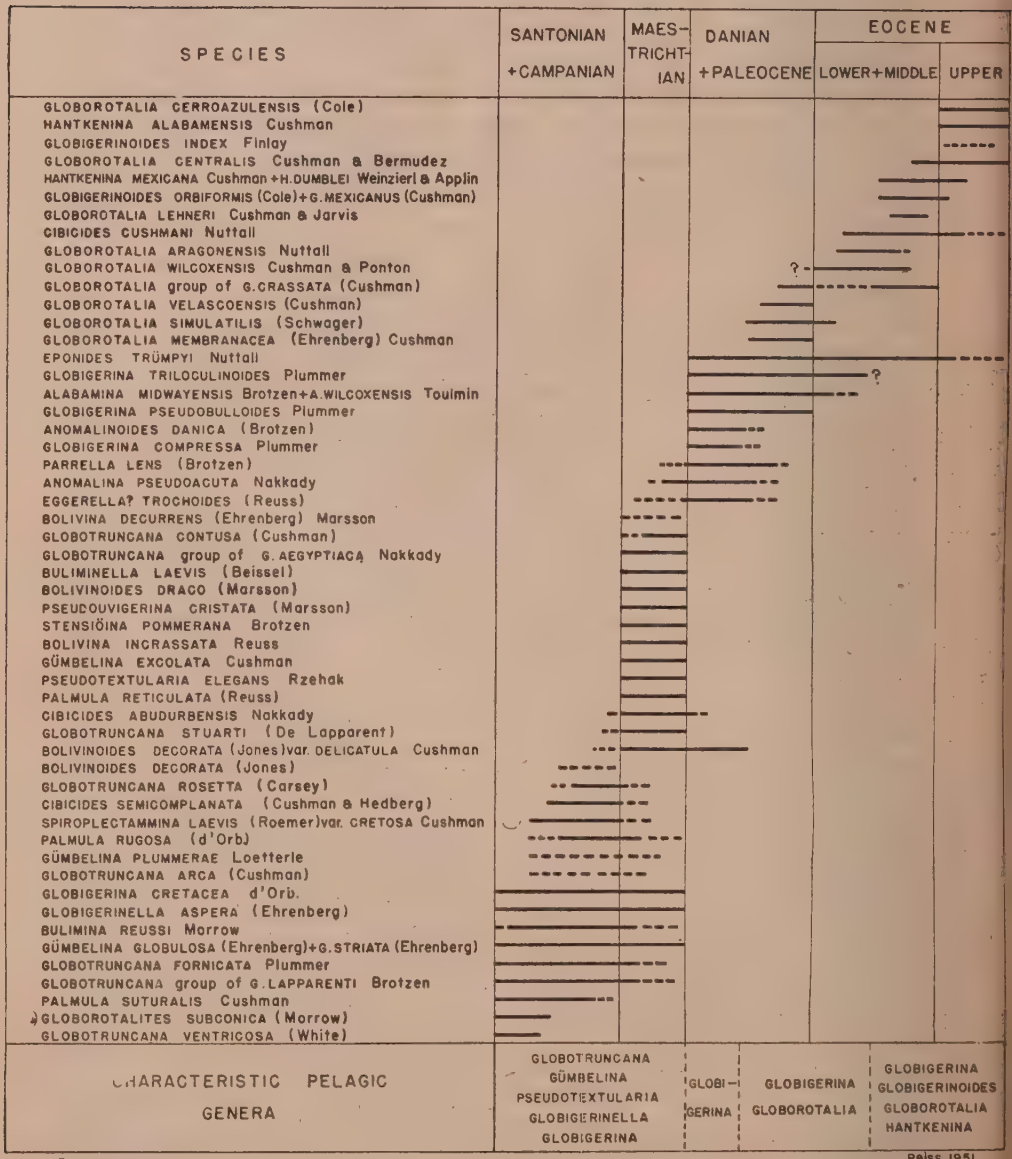
## PRELIMINARY DISTRIBUTION CHART of FORAMINIFERA

### from the Upper Cretaceous — Eocene of Israel




Reiss 1951

LEGEND: ----- Rare — very rare
——— Frequent — abundant

# LATE QUATERNARY SEDIMENTS OF THE COASTAL PLAIN OF ISRAEL*

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## I

In earlier years, the most important investigations on the Quaternary of Palestine were carried out in the inner rift-valleys of the country, especially in the Jordan Valley[1,2,3,4]. These valleys were subjected over a long time to very particular geographical conditions of subsiding areas and therefore it was difficult to correlate their sediments or fossil faunas with those of other regions. It seems now that for this purpose the long Coastal Plain is much more suitable. It was for a long time a popular belief that the beaches of Palestine were rising since some undetermined stage of the Pleistocene, the submarine rocks or those projecting above the sea along the coast and the "raised beaches" being a proof of such an elevation. In reality the "raised beaches" or anything which may be thought of as a "marine terrace" do not exist at all in Palestine or are present only on a very limited scale. The high, steep beaches in many parts of the coast are due to other factors and the material of these beaches is not of marine but mostly of eolian origin. Thus the Israel coast is practically lacking in raised beaches and marine terraces so important for the study of the Quaternary, which are frequently present in Mediterranean countries and are to be seen, for example, in the nearby Lebanon. The study of fluviatiles terraces, which is also of great use in many countries, has not much developed in Palestine, since its rivers, especially those flowing into Mediterranean, are very small, their terraces very modest and much of their "normal" history is often obliterated through the influence of young faulting, which has cut them through and burried great parts of them under recent sediments.

In the last years the research in prehistory which has been carried out mainly in the caves of the western hill slopes, has achieved important results for the Quaternary stratigraphy. The fundamental research of Miss Garrod and Miss Bate, especially in the Carmel caves, has supplied a basis for subdivision of Palestinian Quaternary. The late G. S. Blake[5,6] applied their results in his Geological Map of Palestine, where he divides the Quaternary of the country as follows:

1. Recent dune deposits: dune sands.

* The subject of this note has already been referred to in a lecture on July 1941 before the meeting of the Palestine Botanical Society, but because of the war difficulties, its publication has been postponed. Its interest was renewed in connection with recent investigations by the author.

Received, January 1951.

2. Alluvium : a) Red clay-loam in Northern and Central Palestine, b) Sandy loam (in South).
3. Loess : loess with gravels.
4. Diluvium : chemical sediments—Jordan River and Dead Sea.
5. Pleistocene above Mousterian : sandstone.
6. Mousterian Red Sand : red sand.
7. Mousterian clay : stiff clay with worked flints.
8. Pleistocene-Pliocene : sandstones, conglomerates, dark sand, with little clay (Saqiya), fossiliferous limestone.

Blake's map is one of the attempts to present a Quaternary history of Palestine based on established stratigraphical terms but the meaning of these terms is still very vague and the horizontal distribution of particular horizons is far from being accurate.

L. Picard, having analysed the existing borings of Tel-Aviv in 1935, incorporated the results together with those of other borings of the central Coastal Plain[7]. In his *Structure and Evolution*[4] he then outlined the history of the Quaternary and the genesis of Red Sand, Kurkar, Hamra gravel beds, etc., of the entire Coastal Plain to which the reader is referred. In Picard's attempt to synchronize our Pleistocene with that of Europe he also refers to the Tyrrhenian transgression.

During nearly a score of years I have dealt with the stratigraphy of the Coastal Plain Holocene and Pleistocene and have published several observations on this subject[7,8,9,10,11,12,13]. My attention was first attracted by the high beaches of the coast which allow some sort of inside view of its structure. The beaches near Nathania, almost midway between Haifa and Tel-Aviv, which reach a height of 30 to 50 m may serve as a good example. These beaches, forming a long ridge, were considered by Blake in his map as of Pleistocene-Pliocene in age, the same as the long "Kurkar" ridge extending from Haifa south to Tantura. The northern part of this last ridge, near Atlit, has been considered by Miss Garrod and Miss Gardner[14] as of eolian origin and late Pleistocene in age. The sandstone ridge, e.g. Kurkar on the coast of Nathania is also of eolian origin and a similar series reaches a depth of at least some 50 m below the present sea-level. This proves that the Coastal Plain sank during the Pleistocene and recent times not less than 50 m. Consequently the coast corresponding of this level must have been situated several Km. west of the present one. Similar observations were made and the same conclusions drawn on the coast around Nahariya, near the Lebanon frontier, and examination of many borings has led to the same results.

## II

A synthetic section across the beach near Nathania may be described (from the top to the bottom) as follows (figure 1) :

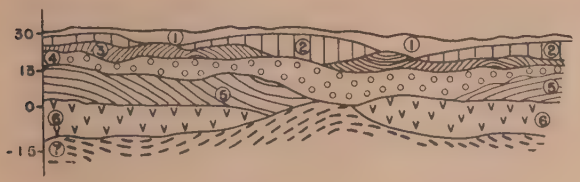


Figure 1

Diagrammatic geological section of the shores near Nathania: (1) Recent dune sands; (2) Loamy and sandy soil with little "Kurkar"; (3) Upper, above Aurignacian dunes ("Kurkar"); (4) Aurignacian red sand; (5) Aurignacian-Levallois dunes; (6) Levallois-Mousterian red sand; (7) Pre-Mousterian dunes.

(1) Recent dune sands: yellowish to slightly reddish sands, sometimes slightly consolidated, consisting for the most part of grains of quartz with few felspars, quite rich in small grains of limestone, composed of debris of Foraminifera, Echinoides, Bryozoa and terrestrial Gastropods. Their thickness is very variable, attaining sometimes many meters. They correspond generally to "Recent dune deposits" of Blake's Geological Map.

(2) Sands or sandy soils, often loamy, very irregularly interstratified by thin layers of consolidated sand ("Kurkar"). The upper parts contain ceramics of early Arab, Byzantine and Roman type; the lower ones contain neolitic artefacts. The thickness mostly modest, rarely reaching some 3 to 5 m. It may partly correspond to Blake's "Alluvium".

(3) Upper ("above Aurignacian") layer of consolidated dune sands ("Kurkar") the thickness of which is rarely greater than one metre and which is often missing altogether. Sometimes the upper surface of this layer contains calcified stems and branches, remains of an old cover of batha-like forest (dwarf shrubs) on the dune surface, possibly of neolitic age. It may partly correspond to Blake's "Pleistocene above Mousterian".

(4) Reddish-brown (cocoa colour), ferro-argilaceous sands, slightly consolidated, containing some species of *Helicinidae* of a living type and numerous artefacts of an Aurignacian type ("Pre-Natufian" of M. Stekelis[15]. This horizon is quite stable and continuous; it can be observed along some 10 km, or more of the coast north and south of Nathania at sea-level or rising to 40 m above the sea. Its thickness varies from 1 to 5—6 m. This formation is one of the most important in the Coastal Plain, appearing in larger or smaller patches on its whole width, up to the foot of the hills. It may probably correspond to Blake's "Mousterian Red Sand", but his term is mainly lithological and stratigraphically not exactly defined.

(5) Lower horizon of consolidated dunes ("Aurignacian-Levallois dunes") of a typical cross-bedded structure, varying in thickness from 0 to 10 m. These sands are rich in minute pieces of marine organisms (Foraminifera, Bryozoa, triturated Gastropods, etc.) and of terrestrial *Helicinidae* of a living type. This horizon could not be correlated with any of Blake's horizons.

(6) Clear-brown ("Café-au-lait" colour) ferro-argilareous sands, slightly consolidated, with many *Helicinidae* (*Helicina, Monacha, etc.*) of types existing now in these areas near the shores and with great *Helix* cf. *cavata,* which does not live now on the areas near the shores and is not found in the superimposed levels of the Aurignacian and of Neolitic to the youngest horizons. This layer is characterized by worked flints of Levallois-Mousterian type which are not very plentiful. On the Nathania coast the Levallois-Mousterian horizon is situated approximately at sea-level often disappearing below this level, occasionally rising up to 4—5 m above the sea-level. Often enough, when the intermediate horizon of "Aurignacian-Levallois dunes" is absent, the Mousterian and the Aurignacian cultural layers merge into one another, making their separation extremely difficult. The Levallois-Mousterian horizon may be roughly compared with Blake's "Mousterian clay". This horizon lays on a Kurkar-sandstone (No. 7) which here mostly descends below sea-level.

Some petrological and micrographical difference (wear or corrosion of grains, their size, proportion of different minerals, etc.) between the particular horizons were found and may be useful as indicative features.

The character and the sequence of the layers below this series, may be learned only from the samples obtained by borings. These are discussed in the last publications of the present author[13]. The boring-samples, however, give us only petrological and palaeontological cirteria, the prehistoric implements, so valuable in this case, being practically unobtainable. In general the borings prove that the continental series continues up to 40—50 m below the sea-level, resting on evidently Lower Pleistocene marine sandstone. This continental series consist of several layers of yellowish sandstone ("Kurkar") alternating with some horizons of more or less reddish-brown sand. Probably some of these deeper brown sand layers (so-called "sandy hamra") correspond to older prehistoric horizons and may be dated where they appear on the surface.

## III

Most of the horizons described in this section extend over vast surfaces of the Coastal Plain. The "Red sands" and the "Kurkar" as also the "sandy hamra" are known to everyone who deals with the geographical or agricultural problems of the country, but all these formations were considered to be contemporary or nearly contemporary; our section indicates that there are several definite horizons of every one of these formations, often well characterized and recognizable and their sequence may be also well established.

The recent dune sands (No. 1) are much less extended than the old dunes consolidated into Kurkar: in southern parts of the Plain they are some five km. or a little more, broad, but north of Tel-Aviv they are mostly reduced to the coastal belt alone. This indicates that the eolian energy of present days is much weaker than that of former times.

The second horizon dating from early Arab to neolitic times, and correspondingly composed of various irregular, thin layers of sand, sandy loam and sandstone, fills the depressions of the underlying surface. The irregularity, the feeble vertical and horizontal development of particular layers illustrate relatively rapid changes of general conditions but of very short duration.

The "above Aurignacian Kurkar" (No. 3) is generally less extended than the Aurignacian-Levalloisian Horizon (No. 5), corresponding to milder climate conditions and shorter duration (less cold, weaker winds, less rains?).

The Red Aurignacian sand (No. 4) is widely spread over practically the whole of the Coastal Plain as well as the southern part of the Coastal Plain of Lebanon[13]. It must have been developed under conditions of hot, semi-arid climate, which allowed man to settle down in the plains. This red sand is of great agricultural importance, being the main soil layer of the Coastal Plain.

The underlying Aurignacian-Levalloisian Kurkar (No. 5) is of great thickness proving long duration of pluvial conditions with strong winds and coldness. Morphologically it is the main rock of the roughly north-south hillock-ridges (known as Kurkar-ridges). Because of its relative compactness, it was used in various times as building material.

The brownish sands of the Levallois-Mousterian horizon (No. 6) and the underlying "Kurkar" (No. 7) are visible along the coast of Nathania only in few outcrops descending mostly below the sea-level. Their origin is similar corresponding to that of horizons 4 and 5. In some parts of the Coastal Plain these horizons may be found in a higher position, as for instance in the Atlit area[14] as also in southern parts from where Pre-Mousterian implements have often been recorded.

This continuous and vast extension of most of the described horizons must have been caused by very general and powerful agents, of relatively great duration. We have shown that the action of these agents is reflected in the nature of the corresponding deposits some of which have been dated by flint implements.

It is now generally recognized that the Kurkar-sandstone represents old consolidated dunes. The wide distribution of these dunes shows that the sands have been pushed eastward by a violent and continuous eolian action. The composition and the texture of the Kurkar-sandstone suggest a regime of heavier rains, stronger winds and relatively lower temperature than to-day. Variously thick gravels penetrating into the pre-Levalloisian Kurkar (as shown by borings) from east, indicate an intervention of rejuvenated fluviatile factors.

On the contrary the Aurignacian and Levalloisian red sand horizons are a product of quite different conditions: the eolian action was greatly diminished bringing the wandering sands to stabilization; the high temperature and the relatively poor rains have caused particular alluvial processes resulting in accumulation of red and brown iron and aluminium compounds. This has been promoted by the influence of rich plant cover.

CORRELATIVE TABLE OF THE GEOLOGICAL HISTORY OF THE SOILS IN THE COASTAL PLAIN OF ISRAEL

| Horizon No. | General Description | "Fossil" remnants | Climatic phases | Prehistoric dating | Marine transgressions | Geologic dating | |
|---|---|---|---|---|---|---|---|
| 1 | Yellowish to light brownish, unconsolidated, non-bedded dune sand | Various of recent times | Interpluvial | Present time | | | |
| 2 | Brown and black loamy sandy soil interstratified with cross-bedded irregular, thin sandstone layers ("Kurkar") | Various of historic to protohistoric times | Short interchanges, of feebly differentiated pluvials and interpluvials. | Historic to protohistoric. | Flandrian | Holocene | |
| 3 | Cross-bedded, yellowish sandstone ("Kurkar") | Few terrestrial gastropods | Pluvial | | | | |
| 4 | Reddish loamy sand, consolidated | Aurignacian implements | Interpluvial | Aurignacian | | Upper Pleistocene | |
| 5 | "Kurkar" | No or rare remnants | Pluvial | Aurignacian-Levalloisian interstage | | | Last Glacial (Wurm) |
| 6 | Brown, loamy consolidated sand | Levallois-Mousterian implements | Interpluvial | Levallois-Mousterian | | | Interglacial |
| 7 | "Kurkar" | No or rare | Pluvial | | | | Middle Glacial |
| 8 | ? Brown loamy sand * | ? Acheulan | Interpluvial | Acheulan | Tyrrhenian | | |

* Below the surface, not discussed in the text.

These two types of sediments correspond to the so-called Pluvial and Interpluvial times which characterize the climatic history of South-Mediterranean Pleistocene. The Coastal Plain was evidently inhabited by early man only during the Interpluvial stages, represented by the red-brown sand formations. During the Pluvial stages the inhabitants were obliged to take refuge in the mountain-caves. For this reason, the sequence of prehistoric levels is much more complete in the caves than in the Coastal Plain: the times of the sterile Kurkar-layers may be well documented by implements in the layers of the caves.

The causes of Pluvials and Interpluvials are well known in their broad lines: they are based on mutual relations with stages of glaciation in Europe and in North-America, so that the Pluvial stages corresponded to glaciations and Interpluvials to regression of the ice-cover. The changes in the extension of ice-cover have had very important influence on the level of seas and oceans, causing their expansion over land or their withdrawal. All these events directed the fate of man and guided his mental and material development.

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# STUDIES ON KRAUSS' ORGAN OF *TMETHIS PULCHRIPENNIS ASIATICUS UVAROV (ACRIDIDAE, ORTHOPTERA)*

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## INTRODUCTION

The structure and function of the oblong, rugouse plate on the second abdominal segment of most *Pamphaginae* (*Acrididae, Orthoptera*) have been the subject of some controversy.

It was first mentioned by Stal[1], then by Graber[2], and was described by Krauss[3] in *Prionotropis hystrix* as a sound-producing organ. Brunner[4] and Pantel[5] did not accept this view. Uvarov[6,7] discussed the matter in full and coined the name *"Krauss' organ"* for this structure considered as an organ for the perception of air pressure.

At the suggestion of Dr. B. P. Uvarov observations were made on the structure and function of this organ in *Tmethis pulchripennis asiaticus* Uvarov.

## DESCRIPTION

The Krauss' organ in adult *Tmethis pulchripennis asiaticus* Uvarov is an oblong plate situated on the anteroventral margin of the second abdominal tergite. It

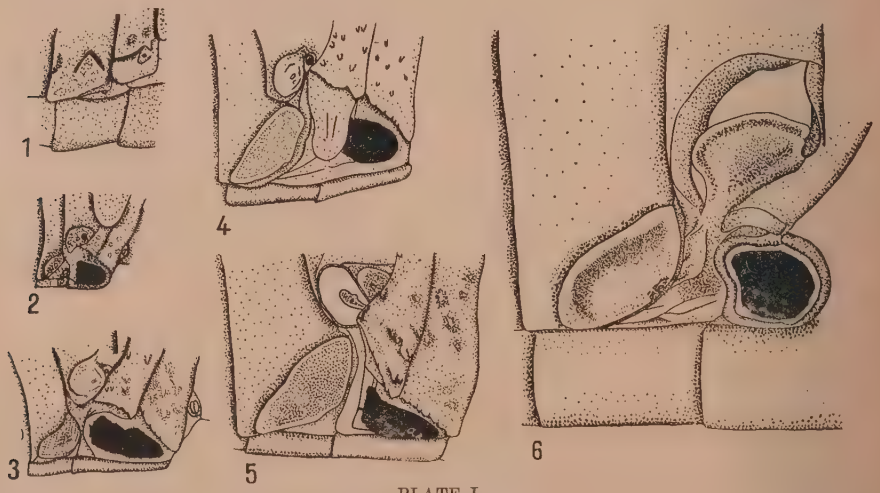


PLATE I

Krauss' organ in various instars of *Tmethis pulchripennis asiaticus Uv*: 1. First instar × 30: only traces of Krauss' organ. 2. Second instar ×7.5, spiracle outside the narrow Krauss' organ. 3. Third instar ×7.5; spiracle embedded in the K.O. 4. Fourth instar ×7.5. 5. Fifth instar ×7.5. 6. Adult female ×7.5.

is diagonally placed with its anterior end elevated dorsad, almost bordering on the tympanum. It is raised above the level of the tergite, and is covered with numerous tubercles, some of which are arranged in rows. The second abdominal spiracle is situated at the antero-ventral border of the plate. The boundaries of the Krauss' organ are clear-cut in adults and subadults, but are less conspicuous in the younger stages. In the first instar, it is hard to demarcate it at all. Plate 1 presents the shape of K.O. in various instars of *Tmethis pulchripennis asiaticus*. The size of K.O. in various instars was measured and compared with the length of hind femur of the same specimen. Table 1 presents the results of these measurements. It appears from this table that the length of the Krauss' organ grows steadily from moult to moult at the same rate as hind femur.

TABLE I

Measurements of the length of K.O. and of the hind femur in *Tmethis pulchripennis asiaticus* Uvarov

| Stage | No. measured | Femur (average) | Krauss' organ (average) | Ratio Femur: K.O. |
|---|---|---|---|---|
| Adults ♀ | 32 | 17.3 | 3.1 | 5.5 |
| Subadults ♀ | 13 | 11.7 | 2.3 | 5.0 |
| IV instar ♀ | 14 | 8.7 | 1.8 | 5.5 |
| Adults ♂ | 10 | 12.6 | 2.2 | 5.6 |
| Subadults ♂ | 2 | 8.7 | 1.6 | 5.7 |

In hoppers of third, fourth and fifth instars, and in adults, the second abdominal spiracle is embedded within the Krauss' organ, but in the first and second instars, the spiracle is situated in the soft membrane ventrad and outside of the Krauss' organ. The Krauss' organ of the second instar is narrow, its width being almost equal to that of the soft membrane between it and the spiracle.

There is a striking resemblance between the Krauss' organ and the triangular areas on the antero-ventral border of the third, fourth and fifth segments. Similar areas have also been found in *Prionosthenus* sp. (*Pamphaginae, Acrididae, Orthoptera*). These areas are easier to be traced on living specimens than on dried ones (Plate 2).

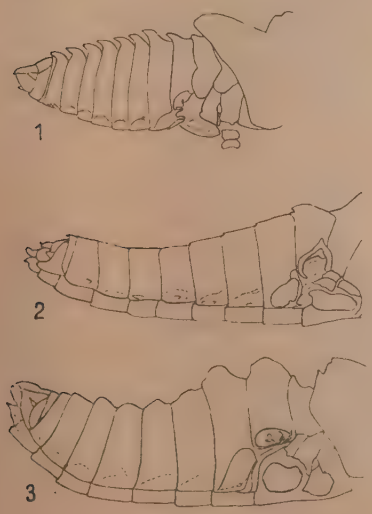


PLATE II

Showing the triangular plates around spriacles: 1. *Tmethis pulchripennis asiaticus* Uv. second instar. 2. *Tmethis pulchripennis asiaticus* Uv. adult. 3. *Prionosthenus galericulatus St.* adult.

The ventral part of Krauss' organ is elastic and may be readily indented. When pressure is released, this part springs back to its previous position. The dorsal and dorsocaudal side of Krauss' organ is thick with a strong chitinous rim. There is a soft membrane between the anterior border of the K.O. and the coxal cavity of the hind leg, as well as between the K.O. and the ventral border of the tergite. When the insect presses its hind legs toward the abdomen (during oviposition or before a jump) it is the Krauss' plate which absorbs the shock, because of its elevation above the level of the tergite. The importance of protecting the second abdominal spiracle is further stressed by the fact that the third to seventh abdominal spiracles are almost closed and are apparently not used in respiration.

## ANATOMY

Twenty *Tmethis pulchripennis* of various instars were injected in the abdomen with methylene blue, then dissected in aqueous solution of Bouin fluid. The differential staining received in this way enabled a close examination of the muscular inervation. The structure of the organs adjoining the inner surface of the K.O. was studied.

A pair of large sacks connected with tracheae lead to the second abdominal spiracle which is embedded in the K.O. The spiracle is provided with a short occlusor muscle and a long opening muscle. There are four peristigmatic glands. A thin branch of a nerve originating in the third thoracic ganglion was observed to terminate in the muscles of the dorsal border of the K.O. Another branch of the same nerve splits in two, one portion entering the opening muscle of the second abdominal spiracle and the other innervating sternopleural muscle of the same segment.

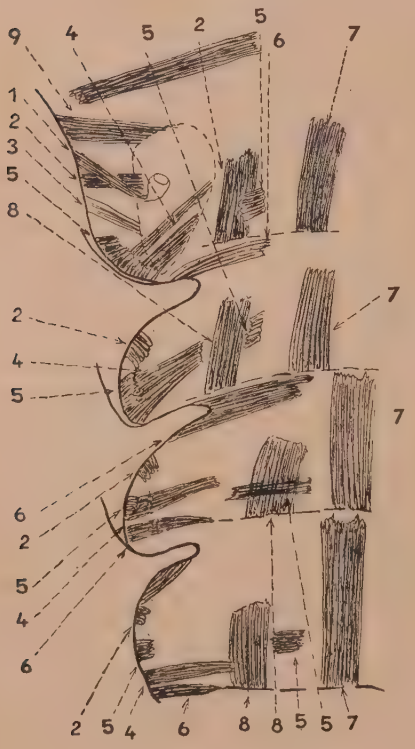


PLATE III

The position of muscles of the second, third, fourth and fifth segments in the tergo-sternal-border area in *Tmethis pulchripennis asiaticus* Uv., adult females: 1. The spiracle-opening muscle. 2. Sterno-pleural muscle. 3. Oblique sterno-pleural muscle. 4. Oblique tergo-sternal muscle. 5. Transverse tergo-sternal muscle *a*. 6. Transverse tergo-sternal muscle *b*. 7. Longitudinal dorsal muscle *a*. 8. Longitudinal dorsal muscle b. 9. Muscle inserted in the anterior border of K.O.

The presence of Krauss' organ has led to certain changes in the number and direction of the muscles of the second abdominal segment. Comparison of the musculature of this segment with that of the third, fourth and fifth abdominal segments revealed that the induced changes are associated mainly with the smaller muscles of the tergo-pleuro-sternal border area, while no changes in the longitudinal sternal and dorsal muscles, or in the transverse tergo-sternal muscle were observed (Plate III, 5). The oblique tergo-sternal muscles (Plate IV, 4), which are inserted in the


PLATE IV

Sections through Krauss' organ of *Tmethis pulchripennis asiaticus* Uv. (1—5) from the antero-dorsal margin towards the postero-ventral end; $6\mu$ staining in Ehrlich-Eosin (×21): 1. Very thick cuticle, specially of the dorsal rim; the muscle inserted in the ventral border of K.O. 2. The cuticle is thinner than in 1; airsack and the above mentioned muscle are visible; fat body abundant. 3. Section through the spiracle; rich fat body. 4. The cuticle is thin; the whole plate is towering over the pleurit and the sternit; strong muscles inserted in the dorsal border of K.O. 5. The hind elastic part of K.O. is visible with the adjacent parts of the segment; many muscles of the hind margin of K.O.

ventral part of the third, fourth and fifth abdominal tergites, are connected to the hind dorstal margin of the K.O. in the second tergite. This muscle is completely covered by the above-mentioned tergo-sternal muscle (5). The sterno-pleural (2) muscle becomes elongated and is inserted into the ventral margin of the K.O. Two muscles, whose origins are not clear, are connected to the dorsal margin of the second sternite and are inserted in the anterior border of the K.O. (9).

This muscular system apparently enables the K.O. to describe slight movements independently of those of the abdomen.

### HISTOLOGY

Six *Tmethis pulchripennis* (adults, subadults and hoppers) were dissected, and the Krauss' organ with the adjoining tissues were fixed in Bouin's fluid. Sections of 6 and 8 μ were stained in Ehrlich-Eosin and in Heidenhein-Eosin.

The sections represent five areas of K.O. from the antero-dorsal edge towards the postero-ventral margin (Plate IV). The Krauss' organ is clearly recognized on the left side of each section by its undulant cuticle. The upper invagination represents the transition from the bordering rim to the rest of the tergite. In sections 1 and 2 the ventral margin of the K.O. is stressed by the muscle inserted in it. The spiracle is seen in section 3.

The K.O. is easily distinguished by the undulant shape of the cuticle and of the underlying hypodermis. The cuticle is thin in the ventral part of the plate, except around the spiracle, and it grows progressivey thicker towards the rim bordering the organ from its dorsal and dorso-caudal side, behind which the cuticle of the integument becomes progressively thinner in a dorsal direction.

The hypodermis is comparatively thick and is often conspicuously columnar, being especially high around the spiracle. No clear sensory differentiation was observed in the cuticle, although the fibres and cells of the peripheral nervous sensory system were seen in several sections.

Abundant fat body fills the spaces between the muscles, tracheas and airsacks.

### EXPERIMENTS ON THE FUNCTION OF KRAUSS' ORGAN IN TMETHIS PULCHRIPENNIS

Certain experiments were carried out on *Tmethis pulcripennis* grasshoppers whose K.O. had been damaged in order to compare their behaviour with that of normal controls. The responses of such grasshoppers to light and to low and high air pressure were studied.

Painting Krauss' organ with lac failed to demonstrate any change in the behaviour of these grasshoppers. K.O. of about twenty grasshoppers (subadults and adults) were put out of action by cauterization with a red-hot needle. At first, insects treated in this way quickly died, but later, when the technique improved, they lived for more than one month, i.e. about the time that normal grasshoppers remained alive in the laboratory.

Five continuous observations of from four to five hours each were carried out on the grasshoppers with both their Krauss' plates damaged as described above. These grasshoppers were maintained together with several normal ones in a spacious cage with a frosted 60 Watt bulb illuminating one corner. The positions of all the grasshoppers were recorded. No difference in behaviour was observed with respect to crawling, eating or basking. Some of the treated grasshoppers courted and mated just as did the normal ones.

Pairs consisting of one treated and one normal adult *Tmethis pulchripennis* were put into 750 cc Erlenmeyer flasks connected with a suction oil-pump. In each experiment the atmospheric pressure was reduced to one fourth normal for five to six minutes, and then restored to normal. The experiments were repeated 3 times with each pair of grasshoppers. Twelve grasshoppers were used in all. No difference whatever in the reaction of the grasshoppers was observed.

Similar observations were carried out on two groups of four male *Tmethis pulchripennis* grasshoppers, two of which had their Krauss' organ damaged as above. The insects were placed in a large exsiccator flask and air was pumped in by means of a hand air pump until the pressure gradually reached 1.5 atmospheres. Each experiment continued for 10 minutes and was repeated 5 times. No difference in response of the normal and treated grasshoppers was detected.

## DISCUSSION OF RESULTS

Sections and microscopic studies of the Krauss' organ showed that it has no particular sensorial differentiation. No conspicuous nerves leading to its integument were observed. Krauss' organ was not demonstrated to play a rôle in the responses of these grasshoppers toward light and air pressure.

Grasshoppers with damaged K.O. did not differ from normal controls in eating, courting or mating.

Since the third to the seventh abdominal spiracles are almost closed and apparently do not function, the remaining ones (and among them the second one embedded in the K.O.) gain in importance. The main respiratory movements consist of lateral contraction of the abdominal tergites and sternites instead of the common contraction of the entire abdomen along its longitudinal axis.

The rôle of the Krauss' organ seems to consist of protecting the second abdominal spiracle against the pressure of the hind femur upon the plump and heavy body.

## SUMMARY

The structure and function of the oblong, rugose plate (the so-called Krauss' organ) situated in the second abdominal segment of *Tmethis pulchripennis asiaticus* Uvarov has been studied.

It was suggested that this plate may possibly protect the second abdominal spiracle embedded in it against the pressure of the hind femur during respiration.

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# LETTERS TO THE EDITOR

**The Editorial Board does not accept responsibility for the views expressed in the letters printed below.**

## ON THE MEASUREMENT OF THE $K/L$ CAPTURE RATIO*

The measurement of the ratio of intensities of $K$-capture to $L$-capture is of a certain importance in nuclear spectroscopy, mainly because this ratio is practically independent of the nuclear matrix-elements.

The determination of this ratio from the intensities of the resulting X-rays is not very accurate and suffers from the lack of reliable data on Auger-conversion coefficients. Also the direct measurement of the Auger electrons is sometimes difficult due to uncontrollable absorptions in the sample and similar effects which are apt to influence markedly the intensities in the regions considered.

One way to avoid these difficulties is to measure the so-called "coincidence spectrum" of the Auger electrons. This consists of the number of coincidences which electrons of a given momentum have with all electrons. With the aid of an accelerating arrangement developed by Schneider *et al*[1], it is now possible to measure electron lines down to about 1 kev, and thus to determine accurately coincidence rates on $K$ and $L$ Auger-electron groups. The following simple case demonstrates how this information can be used to determine the desired ratio.

Assume that the $K$ and $L$ captures are followed by an isomeric transition which leads directly to the ground state, furthermore, that there is neither $K$ nor $L$ capture directly to the ground state ( the decay of $Cd^{107}$ offers an example). Processes which may result in a $K$-Auger electron are those in which a hole in the $K$ shell is created, namely: $K$-capture and $K$-conversion. Processes which may result in an $L$-Auger electron are: $L$-capture, $L$-conversion, as well as all processes which create a hole in the $K$ shell which is filled subsequently by an $L$-electron, etc.

It is easily seen that assuming 100% efficiency for both detectors of the coincidence arrangement, the coincidence rate on the $K$-Auger line turns out to be proportional to $(1+\mu/\varkappa_k)^{-1}$ where $\mu$ is the fraction of $K$-captures ($1-\mu$ is that of the $L$-captures) and $\varkappa_k$ is the $K$-conversion coefficient of the $\gamma$-ray emitted in the isomeric transition. A similar expression can be obtained for the coincidence rate on the $L$-Auger lines. One will bear in mind that, in the example considered, only those Auger electrons which follow a conversion electron, are in coincidence with any electron, whereas those following a $K$-capture are not.

The value of $\mu$ as well as that of $\varkappa_k$ can thus be deduced from the measurements of the coincidence rates on the Auger-electron lines. The relative error in $\mu$ is roughly equal to the larger one of the coincidence rate and the conversion coefficient.

A. DE-SHALIT

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* Received December 1951.

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## EXTENSION OF THE TRAPEZOIDAL RULE TO 3-DIMENSIONS*

The estimation of a given double integral over an otherwise non-integrable function, and what amounts to the same thing, the estimation of a volume, given only depths uniformly taken, may be rapidly carried out by an extension of the well-known trapezoidal rule to three dimensions. The scheme or computation is easily derived, and it may be of assistance in a number of cases.

The actual computation may be simplified by setting the values of the function (or depth) $z$ on intersections of a rectangular grid covering the intervals over which integration is desired, divided in one direction by an odd number of lines spaced equally $d$ part. For convenience in marking, this is taken to be the $x$-direction. There is no limitation as to the division of the other (the $y$-direction), which is also divided by lines $\delta$ apart. The dividing lines are marked as shown.

The scheme is as follows, summation being carried out step by step, no one $z$ being taken twice. The summation sign $\Sigma$ indicates the sum of the values of $z$ taken in the order given.

* Received, March 5, 1952.

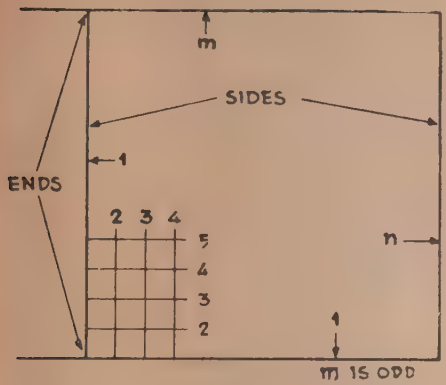


Figure 1

1. $\frac{1}{2}\,\Sigma z$ at corners.
2. $\Sigma z$ along sides.
3. $2\,\Sigma z$ on even numbered lines at ends only.
4. $4\,\Sigma z$ on even numbered lines except at ends.
5. $\Sigma z$ on odd numbered lines at ends only.
6. $2\,\Sigma z$ on odd numbered lines except at ends.

The grand total of the above sums is then multplied by $d\delta/6$.

Where the area over which the function is non-rectangular or, more generally, irregular, it should be wholly circumscribed by the grid, and it will be sufficient to place the values of $z$ at zero at all points outside the given area.

The only advantage claimed for this scheme is an increase in the speed of computation coupled with a smaller liability of error when a large number of intersections must be considered.

Z. RIGBI

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## A POSSIBLE CROSS—VISCOSITY EFFECT IN AIR

Reiner[1] has proposed as the general equation connecting the tensors of stress ($p_{rs}$) and flow (also called "rate of deformation") ($f_{tu}$) in a viscous liquid the following

$$p_{rs} = F_0 \delta_{rs} + F_1 f_{rs} + F_2 f_{ru} f_{us} \qquad (1)$$

and named $F_2$ the coefficient of cross-viscosity. Braun and Reiner[2] have discussed several special cases of flow of such a liquid. The simplest case is laminar flow between two parallel platens, one ($y=0$) at rest, the other ($y=h$) moving with the velocity $v_x = V$, the liquid being open to the air ($p_{zz} = 0$) at $z = 0$. In this case

$$v_x = Gy\,;\; v_y = 0\,;\; v_z = 0 \qquad (2)$$

and

$$p_{xy} = p_{yx} = \eta G,\; p_{xx} = p_{yy} = F_2 G^2)^2 \qquad (3)$$

where

$$G = V/h \qquad (4)$$

while all other components vanish.

When the platens are mutually inclined so that

$$h = h_o + az \qquad (5)$$

an exact solution with only $v_x$ different from zero complying with the above mentioned boundary conditions, is not possible. However, when $a$ is very small, we may, on the model of Sommerfeld's[3] treatment of hydrodynamic lubrication, assume that the velocity distribution Equ. (2) is still valid. We then find, neglecting $az$ and higher orders against $h_o$, that $p_{zz}$ does not vanish, but that there is a gradient

$$dp_{zz}/dz = -F_2 G^2 a^3 y^2/{h_o}^3 \qquad (6)$$

Assuming $F_2$ to be negative, there will be pressures of the amount $F_2G^2/4$ against the walls $y = 0$ and $y = h$ and a pressure gradient $-F_2 G a^3\; y^2/h_o^3$. If we make an opening to air at some distance $z = -H$, the pressure gradient will force the liquid to flow in the direction of decreasing $h$, i.e. towards the narrow end of the space between the platens. Now let the two platens be formed by a cylindrical and a co-axial conical, nearly cylindrical, surface respectively; let the cylinder rotate: then the liquid, if it has cross-viscosity, will be forced to flow in the annulus in the direction of the axis towards the narrow end. Further, let a cylinder rotate in a very viscous liquid which does not wet the cylinder so that there is a narrow annulus of air between both; if we assume that air has cross-viscosity, a pressure will develop in the radial ($y$) direction and keep the liquid away from the cylinder. In addition, because of the hydrostatic pressure in the liquid, the annulus will be narrower at the bottom of the cylinder than at the surface of the liquid. If this is the case, air will be pumped from the outer atmosphere downwards ($-z$) and can be collected in the rotating cylinder, provided the latter is hollow and has a cover at the top, but not at the bottom. This is what actually happens under appropriate experimental conditions, the whole arrangement forming a centripetal airpump.

A detailed account of this investigation will be published elsewhere.

I am obliged to Mr. J. F. T. Blott, in whose laboratory (Shell Central Laboratories) I first

saw this experiment performed. Mr. Blott did not advance at the time any explanation for this piece of "black magic".

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## THE WEISSENBERG EFFECT IN BLOWN BITUMEN

When a Mexican Blown Bitumen, 55 pen, is heated to about 120°C it becomes so fluid that it can be poured out of a beaker. When a vertical rod is rotated in it, lines can be seen, along which the bitumen is drawn to participate in the rotatory movement. However, when the temperature is allowed to drop to about 100°C, a rotating rod shows in addition quite distinctly the Weissenberg effect with the same picture as found by Reiner, Scott Blair and Hawley[1] in sweetened condensed milk. When the temperature falls still more, to about 80°C, the effect becomes even more pronounced, the material climbing up the rod until it is nearly possible to empty the beaker in such manner.

Mexican blown bitumen is an elastic gel[2].

When a similar experiment is repeated with a Lobitos Bitumen, 55 pen, which is an inelastic sol, the lines along which the bitumen is drawn can be seen, but the Weissenberg effect is absent.

We draw the following conclusions: (i) The Weissenberg effect is connected with the elasticity of the material*; (ii) The characteristic lines showing the drawing in of the material are not an indication of a "climbing up the rod"; (iii) The penetration test is of little significance, considering that the two so widely different materials have the same pen-number; (iv) In using a rotating cylinder viscometer for elastic liquid one must beware of errors due to a climbing up on the inner cylinder. We have actually observed such an effect testing Mexican Bitumen in a conicylindrical apparatus.

The present communication forms part of a research pragramme sponsored by the Fohs-Foundation and the Research Council of Israel.

* This does not exclude the possibility of a centripetal pump effect in viscous liquids, due to cross-viscosity[3].

We are obliged to the Road Research Laboratory (Harmondsworth, England) for the bitumen samples.

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## RHEOLOGICAL PROPERTIES OF A HIGH ASPHALTENE CONTENT BITUMEN

Measurements of the rheological properties of markedly elastic bitumens in a conicylindrical viscometer[1] show decreasing viscosity with increasing stresses and with increasing displacements. This can be seen, e.g., from experiments carried out on a bitumen which was produced by vacuum distillation at 280°C, containing 12.6% asphaltene and 3.18% S. The results of the usual measurements in the conicylindrical viscometer are shown in figure 1

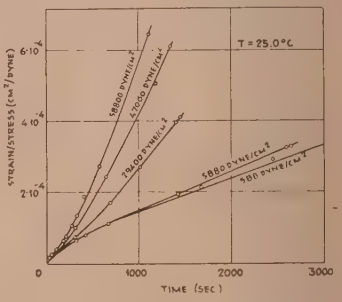


Figure 1

plotting the ratio strain of displacement/stress against time for various shearing stresses applied to the bitumen. To investigate the reason for the marked decrease of viscosity under the mentioned conditions, a new kind of experiment was devised in the same instrument, measuring the total elastic recovery consequent upon displacements of various magnitudes caused by various loads. Results of this are drawn in figure 2, where the strain of elastic recovery is plotted against the strain of displacement for varying shearing stresses. Ac-

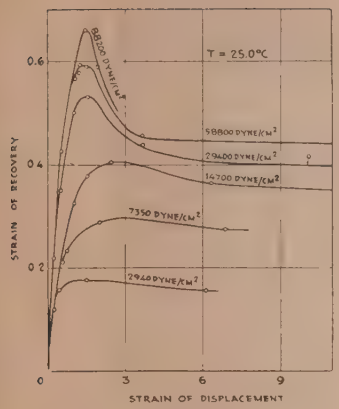


Figure 2

cordingly, the recovery strain curve shows more, or less pronounced peaks, at small displacements. The elastic recovery decreases with large displacements, and for a stress of 29,400 dyne/cm² and a strain of displacement of 124, it is only 55% of the peak value. The elastic recovery equals small dispacements and is then wholly elastic, e.g., at a stress of 29,400 dyne/cm² up to a strain of displacement of 0.25. This limit of elastic strain increases with stress. Subsequent measurements did not influence each other measurably, and the bitumen regained its original steady state structure after 24 hours.

Interpretation of these experimental facts seems to be difficult without the knowledge of the molecular structure of bitumen. This is known only roughly; it is considered that micellae of macromolecular asphaltene and low molecular liquid maltene form a colloidal system[2]. This description of the structure is not sufficient. For the explanation of the experiments, assumption can be made on the basis of the bitumens' measured viscous and elastic properties. They apear to be analogous to those of materials consisting of long chain molecules dissolved in a low molecular weight liquid[3,4], and it is a simple assumption therefore, that the asphaltene is present in the form of close and entangled coils of hydrocarbon chains. The coils become elongated due to configurational elasticity at the beginning of any deformation by rotation of chain segments around molecular bonds. This deformation can be practically recovered, as was proved in the experiments. On continued deformation measurable flow is added to elastic displacement, and uncoiling and orientation of the chain molecules take place. The starting flow limits the increase of the elastic displacements, and this explains the existence of the maximum of elastic recovery. The peak value of the elastic recovery becomes larger with increasing stress because the initial elastic displacement increases. Viscosity is highest before marked orientation occurs. With displacement, viscosity decreases; so does the elastic recovery after its peak value, both due to further orientation of the asphaltene molecules. The larger the stress, the more pronounced the orientation and its effects, as seen from the experiments. Orientation is continued with time at a decreasing rate. It appears thus from these investigations that the elastic and viscous properties, at a certain temperature, are functions of the configurations of the asphaltene molecules in the bitumen.

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## ON THE SEMI-DIURNAL WAVE OF ATMOSPHERIC VAPOUR PRESSURE*

Over a large part of the Earth's surface, both land and water, the diurnal variation of vapour pressure is of a double wave type. A noteworthy feature of this variation is the closeness of the maxima and minima of vapour pressure with the corresponding phases of the daily curve of atmospheric pressure. The correspondence between the phases of these two curves is best near the equator and least in high latitudes. The following contains a theory of this phenomenon:

The maxima of the diurnal variation of vapour pressure, as well as its minima, are spaced about 12 hours apart. Therefore the study has been made by considering the semi-diurnal oscillation of the Fourier series.

$$e_0 + \sum_{n=1}^{\infty} e_n \sin\,(E_n + nx) \qquad (1)$$

of vapour pressure, where $x$ is the time (hour of the day) expressed in terms of angles. Vapour pressure as well as atmospheric pressure $p$, virtual temperature $T$ and density of moist air $\varrho$, are periodic functions with a period of 24 hours. All these variables may be developed in absolutely and uniformly convergent Fourier series. The Fourier analysis makes it possible

* Received, February 1952.

to include in the study the semi-diurnal oscillations of areas where the diurnal variation of the vapour pressure is of the single wave type.

A convenient starting point is the logarithmic form of the equation of state of an ideal gas

$$\log p = \log \varrho + \log T + c \qquad (2)$$

as applied to the moist air, where $c = \log R$, $R$ being the specific gas constant of dry air.

Although we are interested in the phase angles of the Fourier oscillations of the variables and not in the phase angles of the logarithms of variables, nothing is lost by considering the logarithms. It can be shown that if the range of variation of a variable is sufficiently small, as are those of pressure, temperature and density, the phase angles of the two oscillations are, to a good approximation, the same.

Let $a_2$ be the harmonic coefficient of the semi-diurnal wave of atmospheric pressure. It is known that in the first few kilometres of the atmosphere, $a_2$ varies with height approximately as the pressure, or

$$a_2 = (p/p^*)\ a_2^* \qquad (3)$$

where $a_2^*$ is the coefficient at the pressure level $p^*$. It is now assumed that $a$ follows (3) exactly. Hergesell has proved for that case that $A_2 - C_2 = 90°$, $A_2$ and $C_2$ being the phase angles of the semi-diurnal waves of pressure and virtual temperature, respectively. If log $p$, log $\rho$ and log $T$ are replaced in (2) by their respective Fourier series, then by the identity theorem of trigonometric series,

$$a_2 \sin (A_2+2x) = b_2 \sin (B_2+2x) + c_2 \sin (C_2+2x). \qquad (4)$$

$a_2$ and $A_2$, $b_2$, and $B_2$, $c_2$ and $C_2$ are the harmonic constants of the logarithms of pressure, density and virtual temperature, in that order. Assuming the validity of (3), it can be shown from (4) at once that $B_2 = 180°$, whatever the value of $A_2$ otherwise. It also follows from (4) that the harmonic coefficients of the semi-diurnal waves of logarithms of pressure, density and virtual temperature form a right-angled triangle in the manner shown in figure 1.

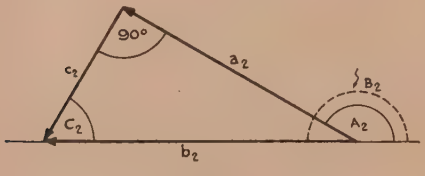


Figure 1

Right-angled triangle formed by the harmonic constants of semi-diurnal waves of logarithms of pressure, density and virtual temperature.

Thus, all the numerous relationships valid for right-angled triangles in the plane are valid between the harmonic constants of the semi-diurnal waves named above.

The atmospheric humidity enters the left-hand side of the equation of state (2) by virtue of its pressure, but it is contained in $\varrho$ on the right-hand side of the same equation. $\varrho$ is made up of two terms;

$$\varrho = \varrho_d + \varrho_v \qquad (5)$$

where $\varrho_d$ is the density of dry air, while $\varrho_v$ is the water vapour density. Variations of the vapour density closely follow those of vapour pressure, and we are thus justified in investigating the phase angles of the vapour density in place of those of vapour pressure. If now Fourier series are substituted for the variables in (5), then a (4) type of relationship appropriate for the present case yields:

$$(270° - A_2) < E_2 < 180°, \qquad (6)$$

$E_2$ being the phase angle of the semi-diurnal wave of vapour pressure or of vapour density. At stations not much above sea level, $A_2$ varies between 125° and 160° and therefore, $E_2$ will not be less than 120°, its upper limit being 180°. Since $A_2$ itself varies within the same limits (excluding higher layers of the troposphere), the observed proximity of the wave phases of vapour pressure, on the other hand, is of atmospheric pressure, on the other hand, is readily understood.

Departures of the real atmosphere from the assumptions made above have been investigated. It was found that in low latitudes where $a_2$ is large, $E_2$ is primarily influenced by the semi-diurnal oscillations of atmospheric pressure. In middle latitudes where $c_2$ has a comparatively large annual variation, the more important influence is that of pressure in summer and that of temperature in winter. In high latitudes, the decisive factor is the temperature oscillation.

A full account of the above study will be published elsewhere.

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## OPTIMAL FLOW IN FRACTIONATING COLUMNS FOR ISOTOPE SEPARATION*

It has been shown[1] that the separating efficiency of certain types of packed distillation columns is inversely proportional to the rate of flow. It is also known[1] that the enrichment of rare isotopes obtained decreases rapidly with

* Received, April 23, 1952.

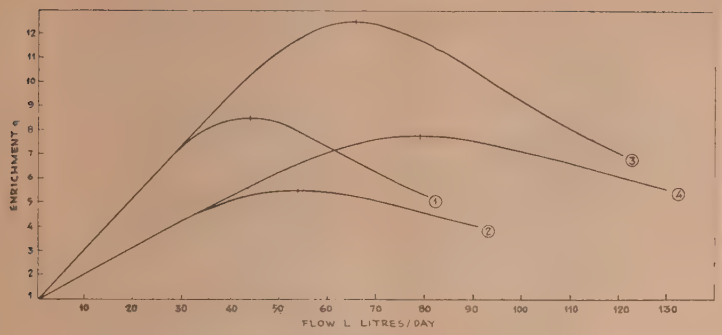


Figure 1

an increase of $p$, the ratio of production to flow. For a constant production rate an increase in flow will tend, through the first effect, to reduce the enrichment while the operation of the second effect will tend to increase the enrichment. This suggested the possibility that for a given column and given production rate there should exist an optimum rate of flow. The effect has in fact been observed and a fuller description will be presented elsewhere. It is the object of this note to outline the theory of the effect.

For a given column producing $P$ moles/day at enrichment $q$, let the rate of liquid flow be $L$ moles/day, $k$ be the transfer coefficient for the system in operation, $Z$ the height of the column in metres, and $\alpha$ the unit process separation factor for the mixture. Then if we operate without a boiler, it is known[1] that

$$q = \frac{1 + \frac{\alpha - 1}{\alpha p}}{1 + \frac{\alpha - 1}{\alpha p} \exp\left[\frac{kz}{L}(\alpha - 1 + \alpha p)\right]} \qquad (1)$$

where $p$ is defined as $\frac{P}{L-P}$, i.e. $L = P\left(1 + \frac{1}{p}\right)$ (2)

For maximum $q$ we need $\frac{dq}{dp} = 0$ and we can deduce that

$$e^{\omega Z} = 1 + \omega Z + \frac{P}{p^2 kZ}\omega^2 Z^2 \qquad (3)$$

where $\omega Z = \frac{kZ}{L}(\alpha - 1 + \alpha p)$ (4)

These equations are sufficient to determine the optimal flow $L = L_{opt}$.

*Approximate solution*

An approximate solution of the rather complicated transcendental equations is possible. Since, in general, $P << L$, we may write $p = \frac{P}{L}$ and then, with some further simple approximation, we can rewrite (3) in the form

$$e^{\omega Z} - (2\alpha + 1)\omega Z = \frac{kZ(\alpha - 1)^2}{P} \qquad (5)$$

Again, since $\alpha - 1$ is small, we may replace (5) by

$$e^{\omega Z} - 3\omega Z = \frac{kZ(\alpha - 1)^2}{P} \qquad (6)$$

Since the right-hand side of (6) is prescribed, the value of $\omega Z$ can be deduced numerically, using a table of the function $e^u - 3u$. Having found $\omega Z$ we can deduce $L$, since, by (4),

$$\omega Z = \frac{kZ}{L}(\alpha - 1 + \frac{\alpha P}{L}) \qquad (7)$$

a quadratic equation whose roots are always real and have opposite signs. The positive root gives the required $L_{opt}$.

The dependence of $q$ on flow is shown in Fig. 1, calculated from equation (1) for $\alpha = 1.0065$. Curve (1) corresponds to $kZ = 23{,}000$ litres/day, $P = 0.03$ litres/day; (2) is for the same $kZ$ but $P = 0.06$ litres/day. Curve (3) is drawn for $kZ = 40{,}000$ litres/day, $P = 0.03$ litres/day, while curve (4) is for $kZ = 40{,}000$ litres/day, $P = 0.06$ litres/day. The points marked on the curves indicate the maxima, as given by the solution of the approximate equation. (7).

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## ON THE DYNAMIC BEHAVIOUR AND WAVE PROPAGATION IN A GENERALIZED LINEAR RHEOLOGICAL BODY WITH CONSTANT COEFFICIENTS*

The simpler, linear rheological bodies — such as the Hookean elastic solid, Newtonian viscous fluid, Kelvin's firmo-viscous solid and Maxwell's elastico-viscous fluid—obey a generalized linear differential equation with constant coefficients between the strain $\varepsilon$ and stress $p$ deviators and their time rates. The various coefficients are correlated to the rigidity modulus $G$, dynamic viscosity $\mu$, time of retardation $T_R$ and time of lagging or relaxation $T_L$.

This linear generalized body behaves symmetrically for positive or negative stresses and strains; additively with respect to stresses and strains; independently of their scales.

Introducing numerical magnitudes of time, stress and energy, a universal equation can be obtained dependent on a single numerical parameter, the time factor $\tau = T_R/T_L$. This defines a principle of similitude for all bodies having equal time factors.

When the body is strained at constant stress or stressed at constant strain, there appear an asymptotic modulus of rigidity and an apparent viscosity variable with time, which may some times become negative.

The study of periodic stresses conducts towards a new classification of all these generalized linear bodies:

(1) When $\tau = 1$, the body vibrates as an elastic Hookean solid.

(2) When $\tau < 1$, the amplitudes are smaller and the energy expended is positive, and it is transformed into heat and warms up the body (adiabatically) or the outside (isothermally). Here belong all simpler linear bodies.

(3) When $\tau > 1$, the amplitudes are larger and the energy expended is negative, i.e. energy is absorbed by the body by adiabatic cooling of the body, by isothermal cooling of the outside or at the expense of other tensor components.

Similar results are derived when impulsive or transient stresses are applied.

When one of the constant coefficients is negative, the strain increases indefinitely with time under constant or impulsive stresses.

The Navier-Stokes equation of this body is derived and applied to the study of wave propagation, celerity and damping.

The generalized linear equation is:

$$p + T_R\dot{p} = G\varepsilon + \mu\dot{\varepsilon}$$

or

$$\varepsilon + T_L\dot{\varepsilon} = p/G + T_R\dot{p}/G;\ T_L = \mu/G$$

and in numerical variables

$$\varepsilon + d\varepsilon/d\Theta = P + \tau \cdot dP/d\Theta;\ P = pG;\ \Theta = \tau/T^L$$

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* Received, March 20, 1952.

## OBSERVATIONS ON THE THERMAL DECOMPOSITION OF POTASSIUM PERCHLORATE*

It has been concluded [1,2] from a study of the decomposition of solid potassium perchlorate that in the first stage of the process, the potassium chloride formed retains the lattice structure of the perchlorate. Only after a finite interval, this structure collapses and is transformed into the "normal" lattice of potassium chloride This has now been confirmed by a roentgenographic study of partially decomposed potassium perchlorate samples at 480°C. These samples which by analysis contained up to 15% of potassium chloride, did not show the lines characteristic of this salt. On the the other hand, these lines appeared with an intensity comparable with that of neighbouring perchlorate lines, in mechanical mixtures of perchlorate with 10% of potassium chloride.

Repetition of the kinetic measurements with refined methods also gave results consistent with the above theory; the curves presenting the rate of decomposition versus time (see figure) consist of a number of successive

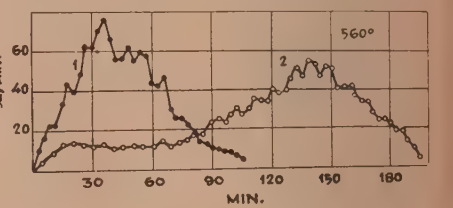


Figure 1

Rate-time curves of two samples of $KClO_4$ at 560° (1) $KClO_4$ B.D.H.; (2) $KClO_4$ Baker's "Analyzed" C.P.

maxima and minima, and they approach zero before the decomposition of the perchlorate is complete. That this phenomenon is not confined to potassium perchlorate, can be seen from a comparison of the data reported by Pavlyuchenko and Gurevich[3] and by Lewis[4], respectively, for the thermal decomposition of silver oxide.

These results induced a re-investigation of the melting temperature of potassium perchlorate, which obviously is dependent upon a previous partial decomposition at this temperature. It has been found that the "point of beginning decomposition" is dependant on impuri-

* Received February 1952

ties present. At the temperatures indicated in table I, appreciable decomposition took place, followed by melting.

TABLE I

*Decomposition Point of Potassium Perchlorate Samples*

| Origin of Sample | Temperature (°C) |
|---|---|
| French, containing 0.5% MgO | 470°—480° |
| French | 520°—530° |
| British Drug House, containing traces of copper | 540° |
| Baker's "Analyzed", containing 0.001% of lead | 560° |
| Baker's "Analyzed", recrystallized and free of heavy metals | 570°—580° |

It appears that the melting point of pure potassium perchlorate would lie well above 600°C[5].

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## OBSERVATIONS ON THE SYNTHESIS OF FLUOROACETATES**

The accepted method for the preparation of methyl or ethyl fluoroacetate is the interaction between anhydrous potassium fluoride and the respective ester of chloroacetic acid. The process is carried out in an autoclave at elevated temperature, the yields on laboratory and industrial scale being 75 and 20%, respectively[1,2]. Apart from corrosion problems, the reaction is sometimes accompanied by an explosive increase in pressure.

The main difficulty lies in the heterogeneity of the system, which is further increased by the formation of potassium chloride coating the surface of the fluoride. The energy of the C-F bond is so much higher than that of the C-Cl linkage, that thermodynamically the reaction should proceed smoothly.

The addition of a common solvent to the mixture of the reactants has, indeed, a beneficial effect. *Such a solvent is acetamide;* at 120°, 100 g of the solution contain 5 g potassium fluoride. Also chloroacetamide and N-methylacetamide are solvents for the fluoride; not, however, dimethylformamide and benzamide.

If alkyl chloroacetates are refluxed with acetamide and potassium fluoride in an efficient column, the corresponding alkyl fluoroacetates distill off continuously and in practically pure form. Some of the esters, which are thus obtained without any pressure, or the need of complicated apparatus, are listed in Table I.

The method proved applicable fairly generally to the introduction of fluorine into aliphatic compounds. Thus, derivatives of ethylene fluorohydrin, fluoropyruvic and fluorosuccinic acid become easily available.

A detailed report will be published elsewhere.

This investigation was carried out under the auspices of the Scientific Department, Israel Ministry of Defence, and is published with its permission.

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TABLE I

*Preparation of Alkyl Fluoroacetates*

| Alkyl | B.P. of chloroacetate (°C) | B.P. of chloroacetate (°C) | Yield (%) |
|---|---|---|---|
| Methyl | 131 | 102 | 55 |
| Ethyl | 144 | 119 | 63 |
| *n*-Propyl | 161 | 137 | 26 |
| i-Butyl | 171 | 150 | 29 |
| *n*-Butyl | 175 | 154 | 42 |

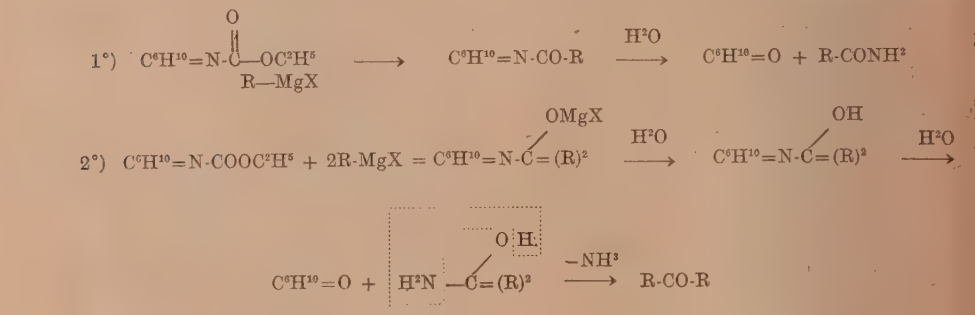
* Published with the permission of this department.
** Received 9.1.52.

## UNE NOUVELLE METHODE DE SYNTHÈSE DES AMIDES

On ne connaissait jusqu'à ce jour aucune méthode de synthèse permettant le passage direct d'un alcoyle halogèné R—X à l'amide R—$CONH^2$ avec un bon rendement. Nous avons entrepris ce travail dans l'espoir de combler cette lacune.

L'action des organomagnésiens sur le cyclohexylidène carbamate d'éthyle, préparé par l'un de nous[1], pouvait se faire de deux manières différentes:

| Amide obtenue | Halogenure de départ | Rendements (calculés par rapport au carbamate) |
|---|---|---|
| Benzamide | Bromobenzène | 91,6 % |
| Amide de l'acide 1-naphtoïque | 1-Bromnaphtalène | 88 % |
| Amide hydrocinnamique | Bromure de phenyléthyle | 60 % |
| Amide p-méthyle benzoïque | p-Bromotoluène | 86 % |
| Amide p-méthoxy benzoïque | p-Bromanisol | 70 % |



L'expérience a montré que seule la première réaction se fait et que l'on obtient ainsi les amides avec d'excellents rendements. (voir tableau).

Toutes ces amides ont été identifiées par point de fusion mélangé avec les mêmes amides préparées par une méthode connue.

Il est à signaler que cette réaction demande pratiquement deux mol. d'organomagnésien pour mol. de carbamate mis en oeuvre. Tous les essais effectués avec une mol. de réactif n'ont donné, après hydrolyse, que la matière première inalterée et le carbure correspondant au magnésien de départ.

Ces faits s'expliquent facilement si l'on admet que le cyclohexylidène carbamate d'éthyle est un mélange en équilibre de deux formes tautomères:

et qu'en présence des organomagnésiens l'équilibre se déplace de (a) vers (b)

L'hydrogèné mobile de la forme (b) du carbamate détruit une mol. de réactif. On retrouve en effet toujours env. une mol. de carbure, correspondant au magnésien mis en oeuvre, dans les produits de la réaction.

Pour éviter la destruction d'une mol. de réactif, qui est le grave inconvénient de cette méthode, nous avons tenté de remplacer le cyclohexylidène carbamate d'éthyle par le benzhydrylidène carbamate d'éthyle

$$(C^6H^5)^2:C=N\text{-}COOC^2H^5$$

dans lequel la migration de la double liaison est impossible.

Cette substance qui se forme par traitement successif de benzonitrile avec de bromure de phényl-magnésium et le chlorocarbamate d'éthyle, distille à 200—210° dans le vide de 14 mm. et fond à 58°. (Anal. calc. pour $C_{16}H_{15}O_2N$: N, 5.5. Trouvé N, 5.7). L'hydrolyse de ce pro-

duit fournit la benzophénone. Sa réaction avec les magnésiens n'a pas conduit à des amides. Une étude du N-méthyle N-tetrahydro-3,4,5,6 phényl uréthane $C_6H_9.N(CH_3).COOC_2H_5$ est maintenant en cours; ce composé ne possede pas non plus d'hydrogène susceptible d'être remplacé par le groupe —MgX.

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## THE ACTION OF BROMIC ACID ON ALIPHATIC AMINES*

In connection with a study on the changes brought about by bromic acid in wool, action of this acid on some aliphatic amines was studied. So far, only the oxidative effect of bromic acid on *aromatic* amines appears to have been investigated[1].

When *n*-butylamine and benzylamine were allowed to react at room temperature with an aqueous solution (30%) of bromic acid, and the water was subsequently removed *in vacuo* at 30—40°, somewhat unstable colourless crystals were obtained. According to their analysis and chemical properties, they represent not the expected salts $RNH_2$-$HBrO_3$, but rather amides, formed according to the following equation:

$$R—NH_2 + HOBrO_2 \longrightarrow R—NHBrO_2 + H_2O.$$

The product from *n*-butylamine has m.p. 86° (decomposes explosively) (*Anal.* Found: N, 7.3; $C_4H_{10}O_2NBr$ requires: N,7.6), those from benzylamine m.p. 61° (decomposes explosively) (*Anal.* Found: N,6.3; $C_7H_8O_2NBr$ requires: N,6.4).

The amide structure receives additional support from the behaviour of the products towards alkali. Titration with N/10 sodium hydroxide at room temperature gives a consumption of only 10% and 15%, respectively of the calculated amount. The theoretical amount of the base was consumed when the products were heated at 80° for 30 minutes with N/10 sodium hydroxide solution.

Iodometric titration of the new products gave a consumption of 2.6 moles of iodine (theor.: 3.0).

The action of bromic acid on $\alpha$-amino acids is now under investigation.

This investigation was sponsored by the Textile Research Association of Israel.

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## THE PHOTO-OXIDATION OF LIMONENE

The photo-oxidation of *d*-limonene[1] proceeds most rapidly at a temperature of 35–40°, the best yield (35%) of limonene hydroperoxide being reached after 140 hours; after this time,

TABLE I

*Product of Photo-oxidation and Subsequent Catalytic Hydrogenation of d-Limonene*

| Fraction No. | Quantity (ml) | B.P. (°C) | Carbonyl (%) | Hydroxyl (%) | Bromine-number† (N/2; ml/ml) | Optical Rotation (°) | Refractive Index |
|---|---|---|---|---|---|---|---|
| 1 | 5 | up to 80 | | | | | |
| 2 | 7 | 80/170 | | | | | |
| 3 | 35 | 174/176 | | | 26.4 | +22 | 1.4605 |
| 4 | 39 | 176/178 | | | 27.2 | +26 | 1.4628 |
| 5 | 9 | 176/184 | | | 28.4 | +30 | 1.4655 |
| 6 | 14 | 180/184 | | | 25.4 | +25 | 1.4663 |
| 7 | 7.5 | 185/205 | | | 27 | +21 | 1.4700 |
| 8 | 16 | 180/210 | 27 | | 30.4 | +18 | 1.4737 |
| 9 | 27.5 | 210/220 | 35 | | 29.6 | + 9.5 | 1.4800 |
| 10 | 41 | 220/224 | 39 | 57 | 28.2 | + 7 | 1.4831 |
| 11 | 36.5 | 226/234 | 39 | 57 | 27.4 | + 7.5 | 1.4857 |
| 12 | 20 | 234/240 | 40.5 | | 25.4 | +10 | 1.4876 |
| 13 | 7 | 240/250 | 35 | | 23 | +14 | 1.4905 |
| Residue | 12 | | | | | | |

† The bromine number of limonene is 56 ml N/2 bromine solution per ml.

* Received, September 16, 1951.

TABLE II

*Treatment of Fraction 9 (Table I)* with boric anhydride*

| Fraction No. | Quantity (ml) | B.p. (°C) | Optical Rotation | Carbonyl (%) | Bromine number (N/2; ml/ml) |
|---|---|---|---|---|---|
| 1 | 9 | 176/178 | 25 | | 25.6 |
| 2 | 8 | 176/180 | 22 | | 26.5 |
| 3 | 2 | 180/205 | | 28 | |
| 4 | 2 | 205/210 | | 43 | |

* A quantity of 25 ml was refluxed for 2½ hours with 4 g of boric anhydride, 25 ml of xylene and 5 drops of acetic anhydride; the product was distilled *in vacuo* and the fractions boiling above xylene were re-fractionated.

it declines slowly, but steadily. The yield obtained represents the balance between formation and spontaneous decomposition of the – evidently very labile – oxidation product.

The composition of the photo-oxidation product was studied after catalytic hydrogenation (in ethanol solution and in presence of palladium, at ordinary pressure and temperatures). The hydrogenated material could be separated by fractionation (Table I) into hydrocarbons (fractions 1 – 6) and oxygenated *p*-menthane derivatives (fractions 7 – 13); all fractions were optically active and contained one double bond per molecule. It was known that the ability of the two double bonds in limonene to add hydrogen is very different[2].

By acetylation and oxidation, the higher fractions were shown to obtain both ketones and alcohols.

An attempt was made to isolate the latter by reaction with boric acid, considered to be the mildest esterifying agent. Nevertheless, substantial quantities of low-boiling material were obtained (Table II), which in their properties resembled the hydrocarbon fractions from the hydrogenated photo-oxidation product. It seems, therefore, that *unexpectedly unstable alcohols are formed in the above hydrogenation reaction*. Their nature is now under investigation.

The similarity of the two hydrocarbon products makes it probable that also in the hydrogenated photo-oxidation product they owe their presence to a breakdown of oxygenated compounds rather than to hydrogenation of limonene which had not been photo-oxidized – although some of their physical constants resemble those of $\triangle^{1,2}$-*p*-menthene[2]. It must, therefore, be concluded that *these hydrocarbons* consist of *bicyclic mono-olefinic compounds*.

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## THE INHIBITION OF DECIDUAL CELL REACTION (DECIDUOMATA) IN THE RAT BY LOCAL ACTION OF DIPHENHYDRAMINE (BENADRYL)*

The experimental production of a decidual cell reaction (deciduoma) in the non-pregnant guinea pig and rabbit uterus[1,2] has been amply verified and extended to the rat[3], dog[4], mouse[5], spayed rat[6], and to the normal and spayed immature rat[7,8]. It has been established that in order to induce this phenomenon of the maternal part of placental tissue in the non-pregnant uterus, two conditions are essential: first the proper combination of hormones acting on the uterus, and second, a "non-specific" irritant applied to the endometrium of the prepared uterus.

Studies are being carried out in an attempt to define the non-endocrine aspects of the mechanism involved in the provocation of the decidual cell reaction. Since one common factor in all types of "non-specific" irritation is a tissue response to injury, and since experiments in progress reveal that intra-uterine histamine injections produced gigantic decidual cell reactions, it was considered that antihistaminic agents should be tested to see whether the effect of "non-specific" irritation in the decidual cell response may be inhibited.

This is a preliminary report on experiments carried out on 12 adult female rats (Hebrew University strain), weighing from 165 to 220 grams. The experimental procedure consisted of producing the required hormonal status by inducing pseudopregnancy[9] by means of electrical stimulation of the cervix[10]. On the third or fourth day of pseudopregnancy, both horns

* Received March 1952

| Animal Number | Experimental Horn Treatment (Uterine) | Result* | Control Horn Treatment (Uterine) | Result* |
|---|---|---|---|---|
| 112.20 | Histamine (0.5 mg) | — | Histamine (0.5 mg) | ††† |
| 112.6 | and | — | | †††† |
| 106.5 | Benadryl (5.0 mg) | — | | †††† |
| 106.8 | | — | | † |
| 112.0 | | †† | | †††† |
| 112.2 | Electrical stimulation | — | Electrical | ††† |
| 112.1 | and Benadryl (5.0 mg) | — | stimulation | ††† |
| 106.4 | | — | | †† |
| 106.2 | | — | | †† |
| 106.3 | Thread loop of silk | — | Untreated silk | †† |
| 112.3 | soaked in Benadryl | †† | thread loop | ††† |
| 106.11 | Thread loop and Benadryl (5.0 gm) | — | Thread loop | †††† |

* Confirmed by microscopic examination
†††† Giant decidual reaction
††† Large decidual reaction
†† Moderate decidual reaction
† Small decidual reaction
— No decidual reaction

of the uteri were irritated, each pair by one of three methods: electrically[11], mechanically by use of longitudinal thread loop[3], or chemically, by intra-uterine injection of 0.5 mg of histamine dihydrochloride in 0.05 cc normal saline. The uterine horn selected as the experimental one for testing the possibility of inhibiting the decidual cell reaction, was treated at the time of irritation, with diphenhydramine (benadryl) by intra-lumen injection of 5 mg in 0.05 cc normal saline. On the fourth post-operative day, the uteri were examined for gross DCR; and fixed in Bouin's solution in preparation for microscopic examination.

The results summarized in the Table reveal that the decidual cell response may be inhibited by the local presence of benadryl at the site of endometrial irritation.

Further experiments are in progress.

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## THE GERMINATION OF LETTUCE SEED

### II. *The influence of fruit coat, seed coat and endosperm upon germination*

The germination of photoblastic seeds in general is strongly influenced by the presence or absence of the different coats enveloping the embryo (summarized by Evenari[1]). For lettuce seeds, different authors[2] state that after removing fruit and seed coat, the seed germinate at high temperatures at which normally no germination occurs, and they do not develop thermo dormancy.

In continuing our studies on the germination of lettuce seed it was imperative for all future experiments to define clearly the role played by the coats during germination.

The first problem was to find out what part of the coat is involved. As lettuce belongs to the *Compositae*, the fruit is an achene containing one seed only. The anatomical structure of the fruit was studied by Borthwick and Robbins[3] and Kondo[4]. Therefore we will only stress a few important points. The coats are composed of fruit coat, seed coat and endosperm (figure 1 and 2). The fruit coat of the black seeded varie-

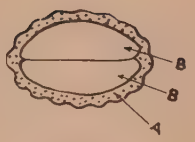


Figure 1

1. Transverse section through achene of lettuce: A—fruit coat, seed coat and endosperm, B—cotyledons.

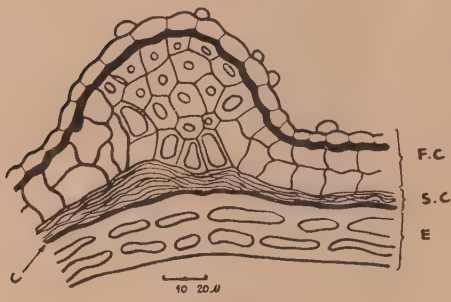


Figure 2

Tranverse section through layer A of figure 1 (variety "Grand Rapids"): F.C. — fruit coat, S.C. — seed coat, E — endosperm; cuticle C is the inner epidermis of the integument which adheres to the endosperm.

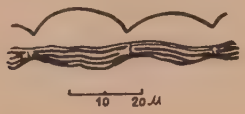


Figure 3

Transverse section through epidermis of pericarp of "Grand Rapids".

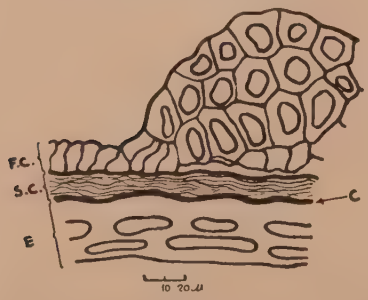


Figure 4

Transverse section through layer A of white-seeded varieties ("Oak Leaf").

ties of cultivated lettuce as well as that of the wild *Lactuca scariola* has an epidermis and a one or two layered subepidermal structure. The epidermal cells contain a black substance which at high magnification shows a band structure (figure 3). The whole epidermis and not only the black colouring material, as most authors state, is completely missing in the white seeded varieties (figure 4). All that remain of the seed coat are obliterated cell walls forming a yellow coloured stratum. The endosperm is composed of two layers of elongated cells completely filled up wth a fatty material. This layer is covered by a very pronounced cuticle which Borthwick and Robbins[3] state to be semipermeable. When the seeds are rubbed between the fingers, the fruit coat comes off easily and the embryo remains covered by the translucent endosperm and part of the obliterated seed coat (figure 5).

The first germination experiments were made with the seeds of the var. Grand Rapids* whose

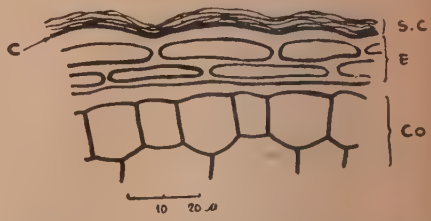


Figure 5

Transverse section through achene of "Grand Rapids" after removal of pericarp: Co—tissue of cotyledons.

fruit coat was removed by rubbing the dry seeds between the fingers. The decoated seeds and the controls were germinated in petri dishes on filter paper which was wetted by 3 ml of water. The dishes were put into light tight boxes and the germination test was carried out in a thermostat in complete darkness at 26°C. After 48 hrs, the germination percentage was determined.

The same method was used in all germination experiments mentioned in this paper. 15 experiments were made in duplicate. The mean germination percentage was 20.9±9.3 (standard deviation) for the normal seeds and 67.2±18.86 for the decoated ones.

This seems to show that the removal of the fruit coat has a pronounced influence on the germination in darkness. But as the described treatment of the dry seeds results not only in the removal of the fruit coat but sometimes also in opening up the endosperm, it was not clear whether the fruit coat or the endosperm is involved. For this reason the following experiment was made. The seeds were soaked in

* We wish to express our thanks to Mr. Frank G. Cuthbertson, vice-president, of the Ferry Morse Seed Co., San Francisco, for supplying the seeds free of charge.

water for 15 minutes in the dark and the endosperm then opened carefully without wounding the embryo. The whole operation was carried out in weak blue light (Corning glass Filter 430) which at the intensity and for the times used did not affect the germination as shown in control experiments. After the treatment, each seed was put immediately into a petri dish in darkness. The resultant germination percentages were: normal seeds 14.9±6.4, decoated seeds 52±14.8 and seeds with open endosperm 93.6±5.7. This experiment proves that not the fruit coat but the endosperm is responsible for inhibition of germination in darkness which is overcome by illuminating the seeds. By opening the endosperm, the light requirement of the seeds is almost completely abolished. The results obtained by Leggatt[5] confirm this. When he ruptured the pericarp he obtained very low germination in the dark. When the "testa" was ruptured germination was practically complete. What he terms "testa" is presumably identical with the endosperm.

But the question remains why decoating without opening the endosperm also stimulates germination in darkness. It seems to us that this is so because by decoating, the endosperm is in a certain number of seeds involuntarily opened up. A proof of this is seen in the fact that whereas opening the endosperm always gave very high germination percentages with very little scatter of values (±5.7), in decoated seeds the germination values were much lower and showed a considerable variation (±18.86). This is borne out by the effect of worsening external germination conditions by increasing the germination temperature to 30.5—31°C. At this temperature the germination percentages in the dark were: normal seeds 0, decoated seeds 2.4± 0.4, seeds with ooened endosperm 56±9.6. At this temperature, light does not stimulate germination of untreated seeds, the germination percentage of illuminated seeds never rising above 2%.

The presence of absence of endosperm is similarly a decisive germination factor when the seeds are germinated in coumarin[2] solutions in the dark. These experiments too were conducted in darkness but the seeds were placed in petri dishes on filterpaper which was wetted with 3 ml of the different coumarin solutions used. The germination temperature was 20°C. This lower germination temperature was chosen because at 20°C, the germination in water in the dark is much higher than at 26°C, thus enabling us to observe the inhibiting effect of coumarin over wide ranges of concentrations.

The results are given in figure 6. It is clearly seen that the germination of the decoated seeds is higher over the whole range of concentrations used.

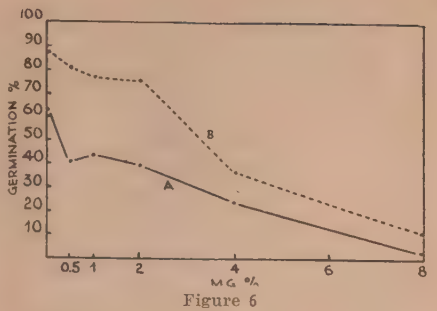


Figure 6

Germination of "Grand Rapids" seeds in different concentrations of coumarin in the dark of intact seeds (A) and decoated seeds (B). Numbers 0.5—8 are mg % of coumarin, numbers 10—100 germination percentages.

But here too, not the removal of the fruit coats, but the opening of the endosperm is the decisive factor. This is shown by experiments where we used only two concentrations of coumarin and germinated at 26°C in order to worsen the germination conditions. The results are given in table I.

TABLE I

| Coumarin Conc. (mg%) | Light or dark | Coats Intact | Decoated | Without endosperm |
|---|---|---|---|---|
| 2 | L | 27 | — | — |
| | D | 0 | 44 | 65 |
| 4 | L | 2.5 | — | — |
| | D | 0 | 4.2 | 22.5 |

It is interesting to note that the effect of light (250 foot candles applied for 2 minutes after 2 hrs. of soaking) in counterbalancing the inhibiting effect of coumarin is far less pronounced than the removal of the endosperm.

SUMMARY

(1) Lettuce seed of the variety "Grand Rapids" which have a very low germination in darkness at 26°C germinate nearly to 100% when the endosperm surrounding the embryo is opened. (2) Removing the fruit coat also has a beneficial effect upon the germination in the dark. This effect is less pronounced than the effect obtained by opening the endosperm. It is suggested that removing the fruit coat involutarily opens the endosperm in some cases. (3) By opening the endosperm, the thermodormancy of the seeds at 30—31°C is broken to about 50%. (4) By opening the endosperm, seeds are made less sensitive towards coumarin, e.g., show less inhibition of germination in a given concentration of coumarin than intact seeds.

The senior author wishes to express his thanks to Dr. James Bonner and the California Institute of Technology, Pasadena, where part of this work was carried out during his stay there.

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## THE LIFE CYCLE OF *HYALOPTERUS PRUNI F.* (*APHIDIDAE, HOMOP.*) IN ISRAEL*

Bodenheimer[1] pointed out that colonies of *Hyalopterus pruni F.* are found on *Prunus* and *Phragmites* during April-June and Plaut[2] recorded its life cycle on almond trees during March-August. The fate of this pest in autumn and winter, the season and form of infestation of almond trees, and the connection between the populations of fruit trees and *Phragmites* was yet to be investigated.

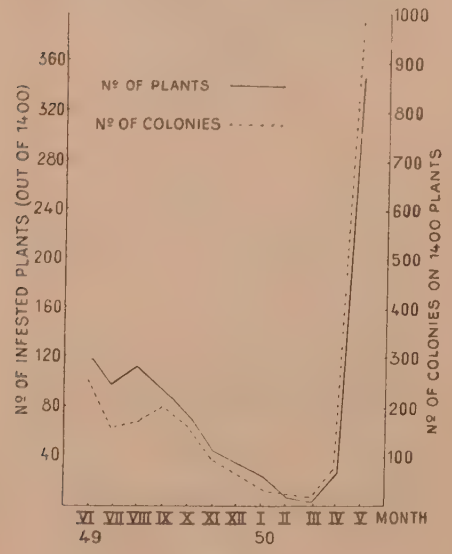


Figure 1
Fluctuations in population of *Hyalopterus pruni F.* on *Phragmites communis* at Wadi-Rubin.

* Received March 1952.

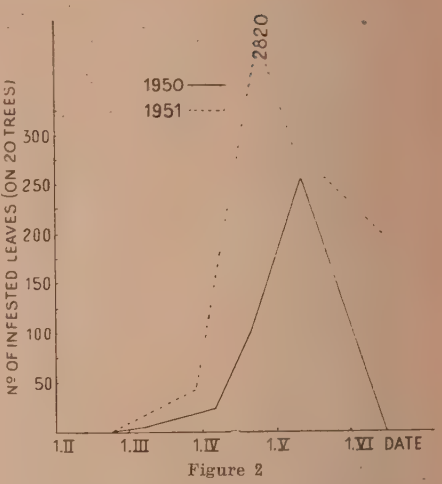


Figure 2
Fluctuations in population of *Hyalopterus pruni F.* on Almond at Mikveh-Israel, in spring and early summer of the years 1950 and 1951.

It was found that in the Coastal Plain, this aphid reproduces parthenogenetically throughout the year on *Phragmites*. The population reaches its peak in the spring and is low in the summer and winter.

100 plants from each of 14 groups growing in various soils and under different conditions were examined, and it was found that in all seasons plants growing in dry soils were much more heavily infested than plants growing in wet soil. The physiological condition of the plants and temperature were other important factors. Examinations of structure of population and re-infestation experiments have shown that there is an alate form responsible for the dispersal of colonies amongst plants of this host.

This aphid has a sexual cycle on almond trees; these are infested in the autumn. In the Coastal Plain the eggs hatch in February, and alatae appear in April. These alatae then migrate to *Phragmites*. Colonies of apterae and nymphs remain, disappearing during the summer. Climatic conditions, the condition of the plants and agrotechnical ways have an important bearing on fluctuations in population. It is important that at the time when the sexual forms appear, there are leaves in good condition on the trees, and when the eggs hatch, there should be flowers or leaves on the trees, so that the larvae can survive. Some varieties

of almonds (Non-Pareil and Ne-Plus-Ultra in contrast to Victoria and Greek) are only slightly infested under the conditions prevailing in the Coastal Plain, where irrigation is practised, the reason being that the trees blossom and break into leaf at a late period. Predators and parasites destroy many aphids but not sufficiently to break the population peak. They are most effective when most of the aphids have migrated elsewhere, when in any case, the almond tree is not a satisfactory host. Alate forms do not spread the population from one tree to another in spring. This is done to a slight extent only, by apterous forms.

The sexual cycle also occurs upon apricot trees infested in autumn. However, the existence of populations on these trees in spring depends, amongst other factors, on the presence of flowers or leaves at the time of the hatching of the eggs. Peach trees were found to be infested in the Hula area.

The existence of a parthenogenetical cycle on *Phragmites* in winter parallel to a sexual one on fruit trees and the dispersal of aphids by alate forms on the first mentioned host are phenomenona differing from the life cycle described in Europe and the United States. In Israel, although there exist conditions which are conducive to the formation of sexuals, there do not exist conditions necessary for the suppression of the parthenogenetic cycle on *Phragmites* during the winter since the above ground parts of this host do not die. This leads to the presence of parallel cycles during the winter, which are similar, to a certain extent, to those described by Das[3].

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## A NOTE ON THE VISION OF THE FACETTED EYES OF INSECTS*

It is a common error that the vision of the facetted eyes of insects is erect with right-left reversion. This view is based on a microphotograph through one facet eye of the Lampyris beetle, published by S. Exner[1] in his classical analysis of the vision of the facetted eyes of arthropods. Exner himself, however, had already pointed out in the legend to that microphotograph, that the right-left reversal is due to the printing from a negative.

The optical analysis of the total vision through the facetted eye shows that the resultant picture from a lens system consisting of many individual facets — which may be defined as tiny cylinders whose index of refraction varies from a maximum to a minimum from the longitudinal axis to the sides of the cylinder — is like a mirror image of an object, namely erect, and the left side of the object falling on the same side as the right side of the image. This fully agrees with Exner's competent analysis.

With regard to the optical system of the individual eyelet, however, there exists the possibility of image reversal, but, of course, right-left reversal would be accompanied by upside-down reversal, as in the human eye. Such a physical possibility depends on the ratio of the length of the optical body to its focal length. If this length is between $4n+1 < f < 4n+2$ a reversed image results and if it is between $4n+3 < f < 4n+4$, an erect image is formed. This then could result in a situation where every image seen through the individual facet would be reversed. Such an embarassing eventuality could be solved by psychological correction, as in the case of the reversed image produced by the human eye. This eventuality, however, is not realized. The angle subtended by that part of the object which forms an image is exeedingly small. The image, therefore, is formed by point projection, and every facet does not contribute more than one entirely undifferentiated point, just like a point in a raster picture. Thus, there remains no doubt that the physical image received by the facetted eye of insects is an erect and straight one.

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Z. Eliash
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* Received April 1952.

# NEWS AND VIEWS

## THE CENTRAL CITRUS PRODUCTS RESEARCH LABORATORY IN REHOVOT

The Central Citrus Products Research Laboratory belongs to the Citrus Concentrates Producers Association of Israel. This Association comprises all ten big citrus factories of the country. It has as its foremost aim the pooling of technical and scientific knowledge and experience to maintain and raise the quality of their products. It was in line with this policy that J. B. S. Braverman, himself a pioneer of the citrus industry in this country, established in 1947, the Central Laboratory, and served as its first director of research. In 1949 he was followed by H. Bernstein, and in April 1950 the writer took over. From its very beginning the Central Laboratory was also supported morally and financially by the Research Council.

Despite this support and the understanding and generosity of the industry and its leaders, the Central Laboratory has not had an easy life. It is situated beautifully but primitively in the orangeries of Rehovot in a former packing house. Never since its establishment have conditions in Israel been favourable to such an enterprise. It has been almost impossible to obtain material, equipment and apparatus. A bomb caused heavy damage during the war of liberation, and only since about six months ago could a minimum of equipment be obtained from the U.S.A. and the most urgent construction work begun. At the present moment the Central Laboratory has a staff of eight, and its scientific and administrative facilities have been expanded to include tomato products and vegetable canning.

The duties of the Central Laboratory are threefold: control, trouble shooting, and research. They have to go hand in hand, none in preference, one influencing and stimulating the others. Problems are many and manyfold, and the small staff must carefully select and know its restrictions and limitations in order not to lose itself in a maze of begun and half-begun projects. From the very beginning the motto, *Service to the Industry* has firmly stood as the general policy of the Central Laboratory. The Central Laboratory maintains close contact with the industry, its leaders and its technicians and chemists. There are regular meetings at the laboratory itself, and some research problems are dealt with together with the factory laboratories. This close connection is a steady source of inspiration and strength to the Central Laboratory. While, due to lack of equipment, a worker in the laboratory may find it hard to overcome difficulties in carrying through a certain experiment on his bench, he will certainly never lack opportunity, cooperation and facilities for the pilot plant stage of the work in one of the factories.

The biggest single impetus the Central Laboratory has received was the recent six month visit of Prof. M. Joslyn to this country. Prof. Joslyn, from the Department of Food Technology of the University of California in Berkeley, has given his full experience, competence, enthusiasm and warm personal interest to the laboratory and has done much to help it in finding the right scientific approach to its many problems.

So far, little work has been published by the staff of the Central Laboratory. Most of it has been made available only to the members of the Association in the form of intermediate reports in the Hebrew language. A list of these shows clearly that at first, practical problems of immediate interest had to be tackled, and that later on, a certain expansion of the work came about. Under the present director, the interest of the laboratory has been led back, to a great extent, to the chemistry and biochemistry of the citrus fruit itself. Studies have been made of pectolytic enzymes and of pectic substances, both so important in the processing of the juice itself and in the utilization of the waste of the industry. Serious preparatory studies of local tomatoes have also been begun. In addition, analytical work concerning the essential oils, distribution of glucosides, trace metals, etc. forms a necessary and important part of the program.

Industry in Israel today is handicapped in many ways. Lack of raw material, equipment and skilled labour call for new and ingenious methods. In this respect, a laboratory like the Central Citrus Products Research Laboratory, where industry and research meet on an equal footing, has a particularly gratifying task to fulfill.

WALTER PILNIK

Rehovot, December 1951.

## THE CENTRAL CITRUS PRODUCTS RESEARCH LABORATORY IN REHOVOT (cont'd)

*List of Available Reports in Hebrew*

Removal of Deposits in Pipes Caused by Citrus Juices

Prevention of Precipitates in Citrus Oil on Storage (Eschinazi, H. E.)

Packing Orange and Grapefruit Cells for Export

A Few Observations on Factory Hygiene in our Plants (Aschner, M. and Cuckierman, I.)

Analytical Indices of Palestinian Orange Oil (Braverman, J. B. S. and Eschinazi, H. E.)

Testing Lacquered Cans for Citrus Juices Preserved with $SO_2$ (Monselise, J. and Rothschild, Gerda)

Observations on the Microflora of the Fruit Surface and its Influence on Juice Production (Aschner, M. and Cuckierman, I.)

Catalytic Dismutation of d-Limonene into Paracymene (Eschinazi, H. E.)

Studies in Viscosity of Citrus Concentrates (Dimant, E and Rothschild, Gerda)

Problems Connected with the Preparation of Pectolytic Enzymes (Dimant, E. and Messinger, Rahel)

Determination of Turbidity in Citrus Juice by the Aid of a Photo-Electric Colorimeter (Stern, F.)

Behaviour of Certain Varieties of Yeast in Juices Preserved by $SO_2$ (Aschner, M. and Cuckierman, I.)

Quality of Israeli Citrus Products upon their Arrival in England (Koffler, M.)

Apparatus for Preheating Barrels Prior to Paraffination

Some Problems in the Industrial Alcoholic Fermentation of Citrus Peels (Braverman, J. B. S., Cuckierman, I., Kraus, W. and Stern, F.)

Survey of Orange Oil Analyses from the Season 1947-48 and 1948-49 and some Suggestions for a Tentative Standard for Israeli Orange Oil (Eschinazi, H. E.)

Influence of Minor Constituents of Orange Juice on Vitamin C Retention, Browning and Flavour of Synthetic Concentrate (Eschinazi, H .E. and Rothschild, Gerda)

The Problem of Isolation of Vitamin C from Peel Juice by Means of Ion Exchange Resins (Eschinazi, H. E.)

Transforming Citrus Peel Juice into Comestible Juice (Braverman, J. B. S.)

Data on Processing of Various Varieties of Tomatoes (Monselise, J. and Cohen, Ruth)

*List of Published Work*

Braverman, J. B. S., 1949, Citrus Products, *Chemical Composition and Chemical Technology*, Interscience, New York.

Braverman, J. B. S., 1947, Mechanical Extraction of Citrus Oils, *J. Ass. Eng. and Arch. in Israel, 8*, 1.

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Joslyn, M. A. and Pilnik, W., 1951, The Citrus Industry in Israel", *C.r.2ième Congrès International de la Conserve*, Paris.

Monselise, J. and Geron, I., 1951, Tomato Pulps of Israel, *Jus de Fruits*, No. 15.

*List of Work Submitted for Publication*

Pilnik, W., and Eschinazi, H. E., Early Citrus Fruits.

Eschinazi, H. E., Orange Oil Production in Israel.

Eschinazi, H. E., Ion Exchange in Citrus Peel Wastes.

Rosenheck, K., Pilnik, W., Monselise, J., Geron, and Haber-Scheim, Shoshanna, Studies on Israel Tomatoes in Summer.

Monselise, J. and Geron, I., Determination of Copper in Tomato Products.

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## JOINT SCIENTIFIC COLLOQUIUM OF THE ISRAEL UNION FOR THEORETICAL AND APPLIED MECHANICS AND THE ISRAEL SOCIETY FOR SOIL MECHANICS AND FOUNDATION ENGINEERING.

A scientific colloquium took place at the Hebrew Institute of Technology, Haifa, on the 17th to the 19th of April, 1952.

The meeting was opened by Prof. M. Reiner as chairman of both associations and the gathering greeted by Prof. Goldstein, Member of the General Assembly of the International Union and Vice-President of the Institute.

The presence of Prof. Tolanski of London in the country offered occasion for the opening lecture by him on his work on microtopology.

The following papers were read in the Mechanics Section.

Mr. N. Klein, "Mechanical Properties of Gas Compression Cables".

Dr. R. Bloch and Prof. M. Reiner, "The Mechanism of Dissolution of Salt Crystals".

Mr. S. Irmai, "The Equation of the General Linear Rheological Body".

Prof. A. Katchalski, "The Rheology of Mechanochemical Gels".

Miss I. Braun, "A New Instrument for the Determination of the Rheological Properties of Gels".

Mr. E. Traum, "The Theory of the Constant Load Extensometer".

The papers read in the Soil-mechanics Section were:

Mr. S. Irmai, "The Application of Darcy's Law for Heterogeneous Media".

Mr. Y. Bashan, Field Experiments on Earth Reservoirs".

Prof. H. Neuman and Mr. M. Peleg, "Experiments on cast-in-situ Piles".

Prof. M. Reiner, "On Dilatancy in Soils".

Mr. M. Ram, "Flow of Water in Drain-pipes".

The colloquium was well attended and the interest showed itself in the discussions. Visits to the Hydrotechnical (Soil Mechanics) Laboratory of the Ministry of Agriculture and to the Rheological Laboratory at the Institute were arranged.

Both, the Union and the Society are interested in accepting new members and invite applications. It should be pointed out that the Society is not an academic body and accepts every person interested in their field.

## INTERNATIONAL SYMPOSIUM ON DESERT RESEARCH

An International Symposium on Desert Research sponsored by the Research Council of Israel in cooperation with UNESCO, which was held in Israel May 7—14th, 1952 brought together over sixty scientists from twelve countries engaged in various aspects of research connected with the development of arid zones.

The symposium was the first full-scale scientific conference to be held in Israel and the first of this scope to be held anywhere. The outline given below listing titles of lectures and their authors describe in brief the subjects dealt with at the conference.

Detailed *Proceedings of the International Symposium on Desert Research* including lectures and discussions in full and other pertinent information regarding the meetings and the participants are being prepared as a separate volume by the Research Council of Israel.

The first days of the Symposium were held in Jerusalem.

*Introductory Lectures for all Sections*

Dry Climates: Their Nature and Distribution — Prof. J. B. Leighly (USA).

Potentialities and Problems of Arid Soils — Dr. C. E. Kellogg (USA).

Biology and Arid Regions — Prof. Th. Monod, F.R.S. (Dakar).

The Surface Movement of Blown Sand — Dr. R. A. Bagnold, F.R.S. (UK).

*Climate*

Design and Use of Homo-climatic Maps — Dr. P. Meigs (USA).

The Water Balance in Arid and Semi-arid Areas — Dr. C. W. Thornthwaite (USA).

Dew Gradients and the Topography, Soil and Climate in Arid Areas — Mr. S. Duvdevani (Israel).

*Biology*

The Physiology of Life and Work in High Ambient Temperatures — Dr. W. S. Ladell (Lagos, Nigeria).

Problems of Animal Ecology and Physiology in Deserts — Prof. F. S. Bodenheimer (Israel).

The Effect of Rain and Temperature on Plant Distribution in the Desert — Dr. P. W. Went (USA).

La Végétation auteur du Chott Hodna indicatrice des conditions culturales — Prof. Ch. Killian (Alger).

Some Aspects of Dry Zone Forestry — Sir Harold Glover (Punjab).

The Water Balance of Plants in Desert Conditions — Prof. M. Evenari (Israel).

Plant Introduction — Dr. B. T. Dickson (Australia).

Chemical Components of Useful or Potentially Useful Desert Plants of North America and the Industries Derived from them — Dr. Peter C. Duisberg (USA).

Problems of Soil Microbiology Relating to Arid Regions—Dr. H. G. Thornton (UK).

*Soil*

Regional Geomorphic Patterns in Relation to Climatic Types in Dry Areas in Australia — Prof. Edwin S. Hills (Australia).

Floods in Deserts — Prof. W. C. Lowdermilk (FAO Advisor to the Government of Israel).

The Struggle between the Desert and the Sown — Prof. A. Reifenberg (Israel).

Problemes pedologiques de l'irrigation des sols arides dans le delta central Nigerien — Prof. G. Aubert (France).

The Nature of the Soils of the Northern Negev — Prof. S. Ravikovitz (Israel).

*General and Explanatory Papers*

Growth of World Populations and Available Land Resources—Prof. A. Bonné (Israel).

Nature and Extent of FAO's Ground Water Studies — Dr. M. R. Huberty (FAO representative in Rome)

The Catchment of Kurnub as an Experimental Station in the Negev — Mr. P. L. O. Guy (Israel).

After two and a half days of lectures and discussions, the scientists made several excursions around Israel. In their trips to the Negev, the Coastal Plain and the Galilee, they had an opportunity to view in practice the subjects of their discussions. In the Negev, they saw the redevelopment of ancient sites and the contrast of old and new methods used to harness and utilize wells, rain and flood waters.

After a visit to the Weizmann Institute and Agricultural Research Station in Rehovot, the group toured along the Sea to Haifa and then proceeded to the Galilee. There they discussed practical problems of plant adaptation and irrigation with members of kibbutzim. They observed reclamation work in the Hula swamp and studied special problems of rehabilitation and intensive agriculture in the Jordan Valley.

The scientists then returned to Haifa where the last day of lectures and discussions was held at the Institute of Technology.

*Water and Energy*

The Measurement of Underground Water Discharges — Dr. P. Danel (France).

Water Conducting and Retaining Properties of Soils in Relation to Irrigation — Dr. L. A. Richards (USA).

The Application of Hydrologic Technique to Ground Water Problems in California's Central Valley — Mr. R. L. Boke and Mr. W. C. Gardner (USA).

Aspects divers de l'hydrologie en region desertique — Dr. M. G. Drouhin (France).

Inter-relation of Surface and Ground Water with Special Reference to Arid Zones — Shri A. N. Khosla (Presented by Shri R. D. Dhir) (India).

The History of Prospecting for Underground Water in Israel — Prof. Y. L. Picard (Israel).

The Utilization of Wind Power — Mr. E. W. Golding (UK).

The summing up address was delivered by Sir Ben Lockspeiser, Director of the DSIR in England. Sir Ben concluded the Symposium by forming a committee which is to consider a set of resolutions to be taken by the members with a view to furthering arid zone work and consolidating the progress that was made in these meetings.

The proposed resolutions suggest that governments of countries containing arid zones should strengthen their research centres, encourage fundamental research and create national bodies where the practical problems of the area can be brought into focus. It was further suggested that some form of coordination for the collection of data should be devised, and training increased for field technicians. The committee appointed to draw up the final draft resolutions for submission to the members consist of Sir Ben Lockspeiser, Dr. P. Danel, Prof. W. C. Lowdermilk, Dr. M. R. Huberty, Dr. F. Malina (UNESCO representative), and Prof. S. Sambursky, Director of the Research Council of Israel.

## NOTICE TO CONTRIBUTORS (cont'd)

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3. Taylor, G. I., 1932, *Proc. R. Soc.* (London, *A 138*, 41.

Book references should be prepared according to the following order:

4. Jackson, F., 1930, *Thermodynamics*, 4th ed., Wiley, New York.

The title of a paper will appear in the references only if it has been published solely in a local Hebrew journal. This is printed in regular type and is indicated by double inverted commas. Only those references should be indicated which are used in the text.

Special consideration is given a bibliography of particular importance. This will appear in full (with titles) and will contain also references not mentioned in the text.

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